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Performance of Humanitarian Logistics affected by Situational Factors

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Le doyen

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Abstract

Humanitarian logistics is a critical element of a successful relief operation. It focuses on the efficient as well as effective management of flows of persons, goods and information during and after a natural or man-made disaster. The objective of this PhD thesis is to investigate how the performance of humanitarian logistics is affected by situational factors (i.e., environmental factors, infrastructure factors, socio-economic factors and governmental factors). First, the relevant academic publications on humanitarian logistics were analysed through a literature review using content analysis, in order to assess which situational factors have been studied so far. Second, a case study research allowed us to analyse the impact of one selected governmental situational factor, namely import barriers, on the performance of humanitarian logistics. The data collection for this case study was conducted in 2011 among four selected organizations, which were chosen following the "polar types" theoretical sampling approach. Third, a system dynamics model was built in order to quantify the impact of different forms of pre-disaster investments on the delivery lead time of relief supplies.

The results found in this thesis contribute to the development of academic research in the field of humanitarian logistics. Furthermore, our findings help relief organizations and institutional donors to understand how performance of humanitarian logistics is affected by governmental situational factors. Finally, our results also help governments to understand the consequences of their decisions on the effectiveness and efficiency of disaster relief operations.

To my wife and children

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1. Introduction

During recent years, humanitarian logistics has become the focus of more and more interest among researchers in the field of operations management as well as supply chain management. Humanitarian logistics is a critical component of a successful disaster relief operation. It focuses on the efficient as well as effective management of flows of goods, persons, and information, before, during and after a humanitarian disaster. Thomas and Kopczak (2005) define humanitarian logistics as "*the process of planning, implementing and controlling the efficient, cost-effective flow and storage of goods and materials, as well as related information, from the point of origin to the point of consumption for the purpose of alleviating the suffering of vulnerable people*".

In all types of disasters, efficient and effective management of logistics enables a humanitarian organization to make the best use of resources, by matching available supplies with highest priority needs in the shortest possible time, under constraint of limited funding and other operational limitations. Academic literature describes different types of limitations and problems, which hinder organizations to fulfil effectively and efficiently the needs of victims of disasters. Researchers recognize several reasons for this, such as poor management practices, lack of preparedness, lack of coordination among organizations, lack of information, lack of skilled logistical staff, poor infrastructure, complex custom clearance, lack of critical supplies in country or lack of investment in technology (e.g., Beamon and Kotleba, 2006, Kovács and Spens, 2009, Pettit and Beresford, 2005, Thomas and Kopczak, 2005, Van Wassenhove, 2006). On the other hand, literature also recognizes enabling factors which help humanitarian organizations to improve their logistic response to disasters, such as information sharing and coordination between organizations, decentralization, local sourcing, effective human resources management (e.g., Day *et al.*, 2009, Gatignon *et al.*, 2010, Perry, 2007, Pettit and Beresford, 2009).

The objective of this PhD thesis is to investigate how the performance of humanitarian logistics is affected by situational factors. As presented in the conceptual framework (Fig. 3.1), these situational factors were categorized into four groups of factors: environmental, infrastructure, socio-economic and governmental. Each of these factors has a specific influence on the performance of humanitarian logistics. This thesis focuses in particular on one governmental situational factor, import barriers, which has been recognized as an important factor by relief organizations, but which was never specifically addressed by any study so far.

The core of this thesis is based on three papers, of which one was published (Kunz and Reiner, 2012b) and two others are in the publication process (Kunz and Reiner, Kunz *et al.*). While these papers are reproduced to a large extent in this dissertation, they have been modified and restructured to increase readability and remove any redundancies.

The thesis will address the following research questions:

(1.1) What are the main characteristics of previous literature reviews done on humanitarian logistics?
(1.2) What are the main dimensions studied so far in the academic literature?
(1.3) Which situational factors found in disaster affected areas influence humanitarian logistics?
(1.4) What are the situational factors most mentioned and studied so far in academic literature on humanitarian logistics?
(2.1) Do import barriers always have a negative impact on beneficiaries?
(2.2) If not, under what circumstances can import barriers be beneficial to the beneficiaries?
(2.3) How can import barriers be beneficial to the beneficiaries?
(2.4) Why do import barriers impact differently on different relief organizations in the same country?
(2.5) What are the characteristics of governments that explain the strength of import barriers and restrictions imposed on relief organizations?
(3.1) How does supply pre-positioning and pre-disaster investment in capabilities reduce the delivery lead time of the relief supplies during the immediate disaster response in comparison to a standard import scenario?
(3.2) What is the potential of pre-disaster investment in capabilities, as compared to pre-positioning, in order to reduce the costs of the preparation phase?
(3.3) How can system dynamics models be best used in humanitarian operations?

In order to answer these research questions, the thesis is structured as follows. Section 2 presents the theory and key concepts on which the thesis is built. Section 3 presents the conceptual research framework, which is the common thread to this thesis. Section 4 is built on our first paper (Kunz and Reiner, 2012b) and aims at answering research questions (1.1) to (1.4). It presents a review of academic literature published to date, through a content analysis of 174 selected papers from high quality journals. This review allowed us to explore all types of

situational factors encountered in humanitarian logistics and find those that were not studied enough so far. Section 5 is built on our second paper (Kunz and Reiner) and answers research questions (2.1) to (2.5). It focuses on one governmental situational factor, import barriers imposed by local governments on importation of relief supplies. This issue was analysed through an exploratory multiple case study research among four relief organizations, with data collected both at the headquarters and at the program level in a disaster affected country. Section 6 is built on our third paper (Kunz *et al.*), and answers research questions (3.1) to (3.3). In this section, the impact of import barriers on the delivery lead time of relief supplies was quantified using the data collected among the case study organizations. In particular, the customs clearance process of a relief supply item was modelled through an empirical quantitative modelling technique. Section 7 provides an overall conclusion of the thesis.

The relevance of this thesis is provided on one hand, by its potential scientific contribution to the field of humanitarian logistics and on the other hand, by its potential contribution to society by establishing a good understanding about the efficient as well as effective utilization of donations. It will also help relief organizations to increase their knowledge on the issue of import barriers, and provide local governments with an understanding of how they can adapt import related policies in order to increase the efficiency and effectiveness of aid delivered in their country. Finally, the findings of the last part of this thesis will encourage relief organizations to invest more into capabilities instead of prepositioning physical inventories during the preparedness phase of a disaster. Because of lower costs and less risks involved, donors will be encouraged to finance such pre-disaster preparedness efforts which have a strong potential to improve the disaster response speed.

The three-step approach followed in this thesis (literature review – exploratory case study – empirical quantitative modelling) is intended to be replicable for studying other situational factors, and represents the major contribution of this thesis in terms of methodology.

2. Theoretical Foundations

The aim of this section is to present the theoretical basis and key concepts on which the thesis is built. After introducing humanitarian disasters and humanitarian logistics, governmental situational factors are presented, and finally, import barriers are described. For each concept, the most relevant publications are cited, along with the major findings from existing scientific literature.

This introductory section does not follow the same objective as Section 4 of the thesis, which provides a more exhaustive and detailed analysis of the overall humanitarian logistics literature.

2.1. Humanitarian disasters

According to Van Wassenhove (2006), every year some 500 disasters cause around 75'000 deaths and affect 200 million people. A disaster is defined by this author as a "disruption that physically affects a system as a whole and threatens its priorities and goals" (Van Wassenhove, 2006). The International Federation of Red Cross (IFRC) defines disasters as "a sudden, calamitous event that seriously disrupts the functioning of a community or society and causes human, material, and economic or environmental losses that exceed the community's or society's ability to cope using its own resources" (Natarajarathinam *et al.*, 2009). Holguín-Veras *et al.* (2012) differentiate between catastrophes, where the local community's ability to respond is strongly compromised, and non-catastrophic disasters, where the local community is able to cope with the consequences of the disaster with its own resources. In this thesis the term "disaster" will be used for catastrophes that require external (most often international) assistance to be solved. This assistance may come from the local government (military, civil defence, etc.), but most often also from relief organizations which have the knowledge, capabilities and resources to help the populations in these crises. Unfortunately, there is strong evidence that the frequency of humanitarian disasters is increasing, and studies suggest that drought and famine will occur again in several regions (Whybark, 2007), therefore research in this field is still needed in the future.

Van Wassenhove (2006) describes four stages in a humanitarian disaster management: *Mitigation, Preparedness, Response* and *Rehabilitation*. Humanitarian disasters are difficult to predict in detail, thus the mitigation and preparedness phases are hard to implement at

reasonable costs. Even though measures can be taken to limit the effects in case of disaster, the preparedness phase is often neglected because donors insist that money be spent directly for helping victims (Kovács and Spens, 2007). A possible solution to this problem is presented in Section 6 of the thesis. The response phase starts instantly after the disaster and aims at responding to the survival needs of the beneficiaries (Kovács and Spens, 2007). Finally, the rehabilitation phase involves the reconstruction of destroyed infrastructure and can last for years after the disaster (Van Wassenhove, 2006). The transition point between the response and rehabilitation phase is not defined clearly in literature, as these phases, and their related activities, are often overlapping.

2.2. Humanitarian logistics

Humanitarian logistic can be described as all logistical activities taking part in the context of a humanitarian disaster. Some authors use alternatively the term “emergency logistics” or “relief logistics” to describe the same concept (Pettit and Beresford, 2005, Sheu, 2007). Long and Wood (1995) argued that most of the disasters occur in less developed regions, which often have inadequate infrastructure, which leads to a major logistical challenge. However, recent disasters (e.g., earthquake, Tsunami and nuclear disaster in Japan in 2011) demonstrated that even in highly developed countries, logistical challenges are considerable in case of disaster. Therefore, logistics has always represented a central part in humanitarian relief operations, and it is estimated to count for 80% of the efforts of relief agencies (Trunick, 2005). Delivering relief supplies to victims quickly, despite the difficult circumstances, is the major challenge of most humanitarian organizations. Their success strongly affects the survival rates of victims, therefore there is a high incentive to improve the performance of humanitarian logistics (Whybark, 2007).

Interest in humanitarian logistics has dramatically increased in recent years, both among practitioners and academics, mainly because of the poor logistics management of the 2004 Tsunami in the Indian Ocean; before, logistics in humanitarian operations was only considered as a necessary expense, and logisticians were not involved in the management of relief operations, as described by Kovács and Spens (2011b). According to these authors, the humanitarian logistics community is currently moving towards a Humanitarian Supply Chain approach, which includes more and more all partners involved in logistics, such as suppliers, beneficiaries, but also local logistic service providers, local companies, and governments.

Kovács and Spens (2011b) also provide an overview on the major achievements that have been noted in the practice of humanitarian logistics during the last years, as, for example, the increase in inter-organizational cooperation and coordination, development of inter-agency purchasing groups, harmonization of custom procedures across organizations, joint warehousing, joint training, and standardization of documents.

On the academic side, several literature reviews and different frameworks have been published so far (Altay and Green, 2006, Kovács and Spens, 2007, Natarajarathinam *et al.*, 2009, Overstreet *et al.*, 2011, Pettit and Beresford, 2009). Several simulation and analytical models have been developed (e.g., Campbell *et al.*, 2008, Gibbons and Samaddar, 2009, Sheu, 2010, Tinguaro Rodríguez *et al.*, 2012, Tzeng *et al.*, 2007, Yi and Özdamar, 2007), and humanitarian logistic theory has been developed (e.g., Jahre *et al.*, 2009). Several academic journals published special issues on humanitarian logistics during the last years, and the Journal of Humanitarian Logistics and Supply Chain Management was created in 2010.

Through the exhaustive literature review conducted in Section 4, the following findings were identified in academic research on humanitarian logistics. Several authors found that information sharing between humanitarian organizations and governments as well as cooperation between organizations, are beneficial for humanitarian logistics (Day *et al.*, 2009, Kovács and Tatham, 2009b, Perry, 2007). Balcik *et al.* (2010) found that partnerships between commercial companies and humanitarian organizations positively influence the effectiveness of humanitarian organizations. Several authors reported that known concepts from commercial supply chains should be increasingly used in humanitarian logistics because they have a large potential of improving humanitarian logistic operations (Ergun *et al.*, 2010, Kovács and Spens, 2009, Pettit and Beresford, 2009, Van Wassenhove, 2006). Similarly, some authors found that specific strengths and attributes of humanitarian logistics, such as quick response capabilities and high flexibility can serve as examples to commercial supply chains as well (Long and Wood, 1995, Van Wassenhove, 2006).

Other problems of humanitarian logistics are also addressed by the existing academic literature, e.g., Altay and Green (2006) detected that planning and support tools are not used enough by practitioners. Based on a field survey among logisticians, Perry (2007) discovered that humanitarian logistic operations generally lack preparedness and need assessments, and that the availability of logistical expertise and skilled staff is often a major concern. This last concern is also recognized by several other authors (Dadzie, 1998, Tatham and Kovács,

2010), which led to the creation of different humanitarian logistics education programs (Kovács and Spens, 2011b). Inventory management and transportation are other challenges, because of product expiration and poor infrastructure (Whybark, 2007). Unavailability of funding for the preposition of inventories in vulnerable areas is another limitation to humanitarian logistics operations (Gatignon *et al.*, 2010).

While humanitarian logistics have been quite extensively studied in literature during the last years, there are still several aspects remaining that need further investigation. Kovács and Spens (2011b) provide a good overview of what still has to be done in their gaps analysis on humanitarian logistics. According to them, current humanitarian logistics research can be criticized for concentrating on a single organization, a specific phase of disaster or a specific type of disaster. Several authors in this field also suggest that until now there has been a lack of empirical research done in humanitarian logistics (Kovács and Spens, 2007, Kovács and Spens, 2009, Pettit and Beresford, 2009).

Current literature has also not addressed the inclusion of humanitarian operations in a development framework, which is crucial to ensure sustainable and long-term effects of aid (Kovács and Spens, 2011b). Long and Wood (1995) for example, mention that relief aid can harm a country in the long run because the distribution of free food dislocates the existing supply network. Therefore, the long-term impacts of humanitarian logistic operations should be carefully considered in further research. This is confirmed by Kovács and Spens (2011b), who noticed that humanitarian organizations are increasingly pushed to consider also social, ecological and economical sustainability of their actions. They noted that local sourcing, local partnerships or incorporation of beneficiaries as active members of humanitarian supply chains, are promising steps in this direction, and should be further studied by researchers. By doing so, the academic community can help humanitarian organizations to develop sustainable exit strategies, which will enable local communities to maintain the reconstruction effort once the international relief organizations have left.

2.3. Governmental situational factors

This thesis will focus on governmental situational factors, in other words external influences from governments on humanitarian logistics. Governmental factors are one of those factors that play an important role in humanitarian logistic operations. Local governments can support the activities of relief organizations, but can also restrict them through different

mechanisms. For this research, we use the description of Downs (1957) which defines a government as the "agency […] which has the power to coerce all other agents in society; it is the locus of 'ultimate' power in a given area." According to this definition and depending on the political context of a territory, the government may be a democratically elected civil institution, an autocratic group, an armed force, or a rebel group that ultimately controls a given territory.

Several authors consider that the impact of the local governments on humanitarian logistics is particularly strong (Kovács and Spens, 2009, Long and Wood, 1995, Seekins, 2009, Whybark, 2007). For example, governments can support the activities of relief organizations through the military (Kovács and Spens, 2007), can coordinate efforts during the relief operation (Oloruntoba, 2010, Tomasini and Van Wassenhove, 2003), and can regulate Non-Governmental Organization (NGO) activities in order to increase their professionalism (Abbey, 2008). On the other hand, governments can also restrict and limit the activities of relief organizations by different means, sometimes closely linked to the political situation in a territory. Some governments use famine as a weapon against civil populations, and try to control and limit the distribution of food (Murray, 2005). In Somalia for example, relief organizations had to use large quantities of food supplies to bribe local warlords, in order to get access to the victims (Long and Wood, 1995). In another case, when Cyclone Nargis hit Myanmar in 2008, the government tried to restrict and control the delivery of relief aid to survivors because it prioritized national state security over human security (Seekins, 2009).

There are also governmental restrictions that are less dependent on the political agenda of governments. The most widely known forms of restrictions imposed by governments are import barriers.

2.4. Import barriers in humanitarian logistics

Import barriers include tariff and non-tariff barriers. While tariff barriers (duties collected on imported goods) have been reduced during the last two decades, a simultaneous increase in non-tariff barriers has been observed (Melo and Grether, 2000, Wang *et al.*, 2011). Such non-tariff barriers are hard to quantify and their effects are hard to measure, therefore they are considered as being non transparent (Melo and Grether, 2000). In the field of humanitarian relief aid, non-tariff barriers can, for example, be imposed through long and complex customs clearance procedures, restrictions on the import of specific items such as medicines or

telecommunications equipment, or by requirements for specific documentation. Often, humanitarian supplies are partially exempted from tariff barriers; however, literature shows that relief organizations are generally confronted with some forms of non-tariff barriers, and these can have a major impact. Indeed, these barriers impact the organizations' preparedness plans (Duran *et al.*, 2011, Kovács and Spens, 2009, Kovács and Tatham, 2009b), create delivery delays (Pedraza-Martinez and Van Wassenhove, 2012, Van Wassenhove, 2006) or may even prevent some supplies from being delivered (Long and Wood, 1995, Tomasini and Van Wassenhove, 2009a). These examples will be presented and developed further in Section 5, which focuses on this topic.

This short overview shows that governmental situational factors, in particular import barriers, are relevant problems faced by relief organizations. However, even though this problem has been mentioned by several authors so far, none of them has conducted a specific research focusing on this important issue. This thesis therefore aims to fill this important gap in existing literature.

3. Conceptual research framework

As mentioned in the introduction, one of the specific contributions of this thesis is the analysis of situational factors found in the disaster-affected area. We define situational factors as exogenous contextual variables, which are present in the disaster affected area and impact the performance of humanitarian logistics. These factors cannot be modified by the relief organizations, yet their impact can be reduced depending on the organizations' abilities to handle them.

Following the advice of Voss *et al.* (2002), who underline the need of having an initial view of "things" to be studied, a conceptual research framework was developed to guide research throughout the thesis, presenting the presumed relationships between constructs and variables (Miles and Huberman, 1994). The aim of the framework presented in Fig. 3.1 is to situate situational factors in the humanitarian logistics context and to develop an understanding of the way they influence the performance of humanitarian logistics.

Mentzer and Konrad (1991) said that performance can be measured as a function of effectiveness (to what extent goals are accomplished) and efficiency (how well resources are utilized). According to Reiner (2004) effectiveness is the degree to which results match the goal, and efficiency can be described as the relationship between what is gained and the level of resources utilized. While the effectiveness of a process in a business environment can be measured by the value it creates (Goldsby and García-Dastugue, 2003), in the context of humanitarian logistics, effectiveness should instead be determined by its fit with the beneficiaries' requirements, in other words, timely delivery of the right relief items. Similarly, efficiency can be defined as the quantity of relief items delivered within a given budget. Performance in humanitarian logistics can therefore be seen as the result of the strategic reconciliation (Slack and Lewis, 2002) of relief organizations' enablers (resources, processes and capabilities) and the requirements of the beneficiaries (e.g., survivability, speed, safety, sustainability). If there is a gap (unsatisfactory performance), it is assumed that relief organizations will adapt their strategies, thus dealing with the operational decision areas (allocation of resources, level of cooperation, outsourcing, etc.), in order to reach a strategic fit between the enablers and the requirements of the beneficiaries.

As presented in Fig. 3.1, relief organizations' enablers (resources, processes and capabilities) are influenced by the availability of donations, which in turn is influenced by the requirements of the beneficiaries and by performance as well.

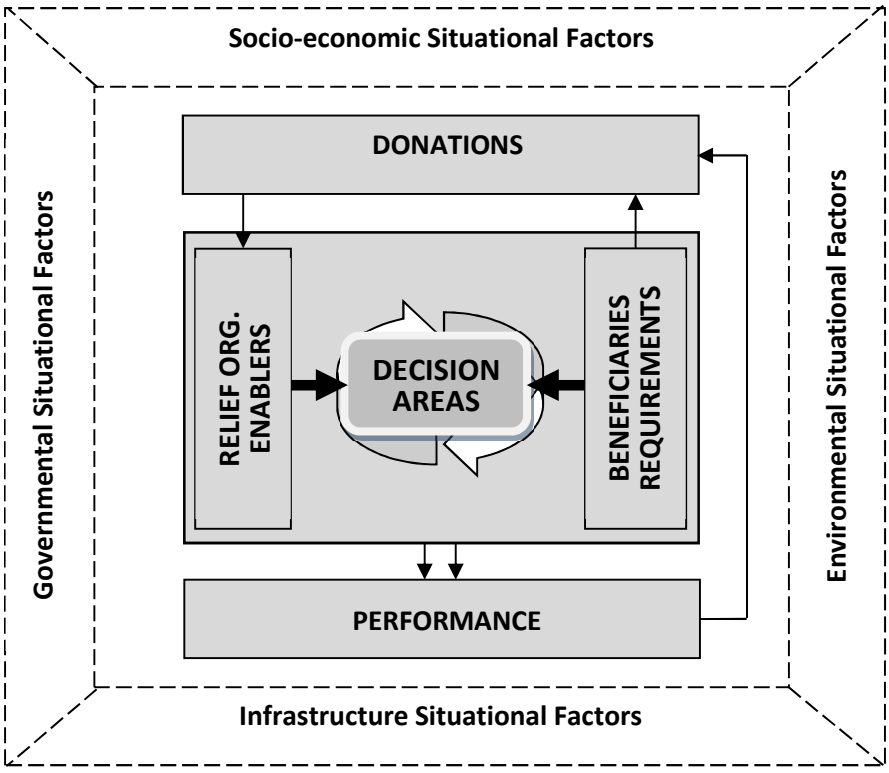

Figure 3.1: Conceptual research framework

In addition, there are also external situational factors, which influence the operational decision areas of humanitarian logistics operations and, ultimately, the performance of humanitarian logistics operations. The following situational factors were identified in existing literature (the details of this process are described in Section 4):

- Governmental situational factors, such as the type of regime, the national regulations toward relief organizations, the efficiency of the state, the level of corruption, are factors that influence organizations' operational decisions and their ability to conduct humanitarian logistics operations. A government which is suspicious of relief organizations' activities will, for example, tend to restrict the entry of staff and goods in the country in the aftermath of a disaster (Seekins, 2009), while a cooperative government will welcome relief organizations on its territory (McLachlin and Larson, 2011, Van Wassenhove, 2006). The security context in a country is also dependent from the

government (or its absence), and strongly impacts the performance of the logistics response (Long and Wood, 1995).

- Socio-economic situational factors, such as the type of market economy, the presence of local suppliers, the level of education of the population, the local culture and religion will oblige relief organizations to adapt their operation to the context, and can affect the performance of humanitarian logistics (Altay *et al.*, 2009, Dowty and Wallace, 2010, Kandiyoti, 2007, Leon *et al.*, 2009, Maon *et al.*, 2009). In a well-developed economy, basic supplies can be purchased from local suppliers, and staff can be hired locally for logistical activities. In a less developed context, all supplies have to be imported and most tasks must be managed by expatriate staff.
- Infrastructure situational factors, such as the availability of a road network, railway, airports, harbours, power supply, play an important role in the performance of humanitarian logistics (Chakravarty, 2011, Nolz *et al.*, 2011, Pazirandeh, 2011, Vitoriano *et al.*, 2011). Indeed, the existence of a well-developed road infrastructure will, for example, facilitate the logistical operations, while a poor road network tends to disrupt and slow down the distribution of relief items for example. The presence of an airport close to the disaster location will facilitate, for example, the delivery of relief aid.
- Environmental situational factors, such as the weather, the topography, geography, vegetation, presence of water, effects of climate change, also affect humanitarian logistics (Benini *et al.*, 2009, Jahre *et al.*, 2009, Linnerooth-Bayer *et al.*, 2005, Majewski *et al.*, 2010, Smirnov *et al.*, 2007). Heavy rainfall can for example hinder the dispatching of trucks delivering relief supplies. Delivering aid to victims of a disaster in a mountainous area of Pakistan requires different strategies and equipment than assisting beneficiaries in the Sahel.

The process conducted in Section 4 analyses how frequently these situational factors have been studied so far. This allowed identifying the factors for which more research should be done.

4. A meta-analysis of Humanitarian Logistics research[1]

In recent years, an increasing number of natural and man-made disasters have hit various regions in the world, killing thousands of people and causing millions of indirect victims. Following the Asian tsunami in 2004, humanitarian logistics was publicly recognized as playing a central role in the disaster relief effort (Kovács and Spens, 2007), and as a consequence, a new field of research emerged. Since then, the field of humanitarian logistics has been extensively studied, especially during the last three years. Five literature reviews have been published so far on this topic since 2006, which are presented in detail in Table 4.1. These reviews all follow a rigorous research process, and provide highly valid results, although with different specificities and perspectives. This section aims at providing a meta-analysis of existing literature by using concepts developed in previous reviews. For example, the keywords for the material collection were defined based on keywords found in these reviews. Also, the material collection process was designed based on databases and list of bibliography used in these reviews. Finally, the framework for the classification of papers was developed based on structural dimensions and categories found in these reviews. The use of such previously validated concepts increases the reliability of this meta-analysis.

In addition to these specific elements taken from existing reviews, the relevance and the contribution of this work to academic knowledge is provided by the following distinctive features. First, although this meta-analysis does not claim to include all papers published in this field, we include the most exhaustive set of papers and journals, as 174 papers from 68 academic journals are analysed. This is mainly due to the fact that this review covers all papers available until end of 2011, and therefore reflects the strong growth in publication of these last years. Second, the papers of our selection are analysed with the content analysis methodology as described by Seuring (2005), which is particularly suitable for conducting a literature review, as it helps to identify the conceptual content of a field by analysing documents in a structured and reproducible way (Ryan and Bernard, 2000, Seuring *et al.*, 2005). Third, this meta-analysis uses a new theoretical framework we developed (Section 3, Fig. 3.1), which presents the exogenous situational factors impacting humanitarian logistics, and the contribution from existing literature is analysed on this dimension. Finally, a quantitative methodology

[1] Originally published under the title: Kunz, N. & Reiner, G. (2012), "A meta-analysis of Humanitarian Logistics research". *Journal of Humanitarian Logistics and Supply Chain Management*, Vol. 2, No. 2, pp. 116-147. http://dx.doi.org/10.1108/20426741211260723

was developed, allowing us to analyse and categorise papers according to these situational factors, based on the occurrence of specific keywords.

In particular, this section tries to answer the following research questions: (1.1) What are the main characteristics of previous literature reviews done on humanitarian logistics? (1.2) What are the main dimensions studied so far in the academic literature? (1.3) Which situational factors found in disaster affected areas influence humanitarian logistics? (1.4) What are the situational factors most mentioned and studied so far in academic literature on humanitarian logistics? By answering these questions through a qualitative and quantitative content analysis, this work attempts to generate possible tracks for relevant future research that has not yet been addressed by previous authors.

First, we present the theoretical background on which this meta-analysis is built, through the existing literature reviews in this field. Then we present the content analysis methodology which was used. The main results of this analysis are then presented and discussed. Finally, the section ends with a summary of the main findings.

This section bases on our paper published in the Journal of Humanitarian Logistics and Supply Chain Management (Kunz and Reiner, 2012b). An earlier version of this contribution had also been presented at a conference (Kunz and Reiner, 2011).

4.1. Theoretical Background

In order to provide an overview of the research history in this field of research, Table 4.1 presents a meta-analysis of the literature reviews published so far. This table presents the main characteristics of these reviews, and constitutes the starting point for our own literature review. Additional details about the methodology, findings and suggestions for further research of these reviews can be found in Appendix A. These literature reviews analyse between 51 and 118 papers, which were published until 2009. Due to the strong increase in publications during the last two years, there is a need for a new, broader review.

As can be seen in Table 4.1, only two reviews cover specifically the literature on humanitarian logistics (Kovács and Spens, 2007, Overstreet *et al.*, 2011). In their paper published in 2007, Kovács and Spens (2007) conduct a qualitative literature review of the field of humanitarian logistics, with the aim of creating a classification framework for disaster relief logistics. They provide useful definitions and attributes of humanitarian logistics, which will be

used in our review. Overstreet *et al.* (2011) also perform a review of papers focusing on humanitarian logistics, but they use a definition of disasters which implicitly excludes slow onset disasters. For this reason and because they focus on the most relevant papers only, their selection of papers (51) excludes a significant proportion of the literature.

The others reviews include papers on humanitarian logistics, but do not specifically focus their paper collection on this field. Altay and Green (2006) published a review of research conducted on disaster operations management in the field of operational research. Therefore, their analysis is limited to papers published in OR journals and does not specifically focus on humanitarian logistics. Natarajarathinam *et al*. (2009) concentrate mainly on the field of supply chain management in times of crisis, which has a broader scope than humanitarian logistics, but bears many similarities to this field. Natarajarathinam *et al.* (2009) provide a useful framework which inspired our classification of papers according to different structural dimensions. Pettit and Beresford (2009) perform a literature review on critical success factors in commercial supply chains, and consider their applicability to humanitarian aid. Although this review covers our research topic, it does not analyse humanitarian logistics literature.

TABLE 4.1: META-ANALYSIS OF PREVIOUS LITERATURE REVIEWS

Criteria	**Altay and Green (2006)**	**Kovács and Spens (2007)**	**Natarajarathinam *et al.* (2009)**	**Pettit and Beresford (2009)**	**Overstreet *et al.* (2011)**
Scope	OR/MS literature in disaster operations management	Literature on humanitarian logistics	Literature of supply chain management (SCM) in times of crisis	Literature about critical success factors in the commercial context	Literature on humanitarian logistics, sudden onset disasters
Aim of research	- issues in disaster operations management - survey existing OR/MS literature - suggest future research directions - tutorial for interested researchers	- discover and describe characteristics of humanitarian logistics in disaster relief operations	- provide a framework to classify SCM literature in crisis management - identify current and future research directions	- identify critical success factors for humanitarian aid supply chains - discuss the applicability of success factors from commercial supply chains to humanitarian aid	- provide a framework for conducting research in humanitarian logistics - analyse the primary focus of humanitarian logistics research - review areas identified for further research
Search techniques	- keywords in databases - citations from articles	- keywords in databases - citations from articles	- keywords in databases - searches in SCM, OR, logistics, management science journals	not specified	- keywords in databases - citations from articles
Number of papers	109	not specified	118	not specified	51
Time coverage	1980 – 2004	... – 2006	… – 2008	… – 2009	… – 2009

Criteria	**Altay and Green (2006)**	**Kovács and Spens (2007)**	**Natarajarathinam *et al.* (2009)**	**Pettit and Beresford (2009)**	**Overstreet *et al.* (2011)**
Inclusion criteria of papers	- OR/MS literature - all phases of disasters - all types of disasters according to IFRC definition	- humanitarian logistics literature - all phases of disasters - all types of disasters	- literature on supply chain crisis - all phases of disasters - all types of disasters	not specified	- humanitarian logistics literature - all phases of disasters - sudden onset disasters
Inclusion criteria of journals	- academic OR/MS journals	- academic journals - practitioners journals - websites	- academic SCM and OR/MS journals - case publications in SCM literature	not specified	not specified
Classification of papers?	yes	no	Yes	no	yes
Data analysis	quantitative & qualitative	qualitative	quantitative & qualitative	qualitative	quantitative & qualitative
Differentiation	No other previous study surveyed OR/MS literature in disaster operations management	No other previous study developed a framework for humanitarian logistics	No other previous study analysed literature about managing supply chains in times of crisis	No other previous study analysed critical success factors applied to humanitarian aid	No other previous study developed a framework for future research based on theory of constraints

4.2. Methodology

As mentioned by Seuring *et al*. (2005), a literature review fulfils two functions. First, it summarizes the existing state of research on a topic by identifying the main themes and issues, and thus provides a starting point for new research. Second, any scientific contribution has to be enfolded against the existing scientific knowledge and theories, and in this regard a literature review is a useful tool (Saunders *et al*., 2009). However, despite the importance of this tool for academic research, the processes of collecting and analysing literature are often less thoroughly described than an empirical research process would be, which calls for more rigorous, systematic and reproducible literature reviews (Seuring *et al*., 2005).

In this respect, and according to several authors, content analysis is particularly suitable for conducting a literature review, as it helps to identify the conceptual content of a field by analysing documents in a structured and reproducible way (Ryan and Bernard, 2000, Seuring *et al*., 2005). Content analysis is a method used in empirical social sciences, which can be applied in a quantitative or qualitative way (Seuring *et al*., 2005). Berelson, one of the founders of content analysis, defines it as a "research technique for the objective, systematic and quantitative description of the manifest content of communication" (Berelson, 1952). A broader definition states that content analysis is "any methodological measurement applied to text (or other symbolic materials) for social science purposes" (Shapiro and Markoff, 1997). A specific strength of this method is that it can combine qualitative approaches with powerful quantitative analyses (Duriau *et al*., 2007). Due to these different strengths, the content analysis methodology has been used by many authors in the field of operations management to analyse formal and content aspects of the existing literature (Bryman, 2006, Croom *et al*., 2000, Denizel *et al*., 2003, Giunipero *et al*., 2008, Reisman and Kirschnick, 1994, Seuring, 2008, Spens and Kovács, 2006). However, it has not been applied so far to humanitarian logistics.

For Brewerton and Millward (2001), both qualitative and quantitative aspects of the data have to be considered when performing a structured content analysis. According to Seuring *et al*. (2005), quantitative and qualitative methods are not contradictory methods, but can support each other well. Patton (2002) mentions that it is possible to move from qualitative data to quantitative analysis; however, she stresses that the reverse is not possible. In his book on

mixed methodologies, Tashakkori (2006) calls this process the "quantification of qualitative data", which can include, for example, the occurrence count of certain themes.

For our literature review both qualitative and quantitative content analysis was used. First, the papers were categorized according to five structural dimensions, based on a qualitative analysis. Second, a quantitative method was used in order to categorize the papers in the sixth structural dimension, the situational factors.

4.3. Model

For conducting this literature review, the process model for content analysis described by Seuring *et al.* (2005) was applied. The four steps of the model are shown in Fig. 4.2 and are described in detail below.

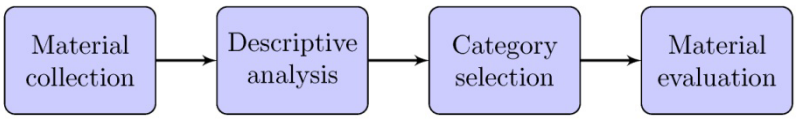

Figure 4.2: Process model for content analysis (Seuring et al., 2005)

4.3.1. Material Collection

In this first step, the unit of analysis was determined. For our review, we analysed single academic papers. Then, the articles to be collected were defined and delimitated following the process described in Fig. 4.3. We used a hybrid identification method for the papers. First, academic papers were collected from the extensive bibliography list published by Peter Tatham (2012) on the website of the HUMLOG Institute, a research institute on humanitarian logistics regrouping the most well-known academic institutions in this field.

Second, a search in databases was conducted. The following keywords and Boolean operators were searched for in the fields "Title", "Abstract" or "Keywords":

(Logistic OR Supply Chain*) AND (Humanitarian OR Relief)*

These keywords were inspired by the keywords used in previous literature reviews. The search was limited to peer-reviewed publications only, and book sections, conference proceedings, reports and practitioner journals were excluded from our selection. This search was

performed in March 2012 using the following databases: Business Source Complete (EBSCO), Science Direct, ABI/INFORM Global and Web of Science, and included all papers published or made available online until the end of 2011. After this hybrid selection mechanism, the papers were filtered according to a quality criterion, in order to analyse only highest quality contributions. Therefore, we retained only papers from journals which are included in at least one of the following rankings: the German VHB (2011), the British ABS (2010), the French CNRS (2008) or one of the US (Olson, 2005) rankings. In addition, we also kept papers from all journals contained in the Journal Citation Reports (Thomson Reuters, 2010), as well as from recent journals such as the *Journal of Humanitarian Logistics and Supply Chain Management* (because of the time it may take to get incorporated into journal rankings). This combination of rankings led to the selection of 68 journals, which are listed in Appendix B.

After the above mentioned filter based on rankings, the papers were filtered based on their relevance to the topic. Therefore, the last step of the selection process was a reading of abstracts, as proposed by Jahangirian *et al*. (2010), and irrelevant papers were eliminated from the selection. After this material collection process, 174 papers were left in the selection.

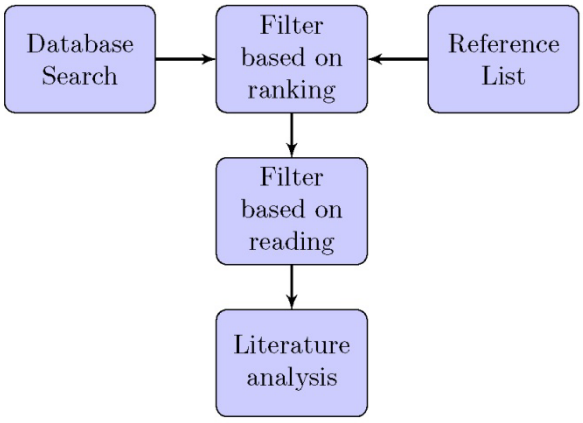

Figure 4.3: Material collection process

4.3.2. Descriptive Analysis

In this step, the formal aspects of the selection of the literature were assessed. We decided to focus on the number of publications per year, as well as the number of papers per journal, in order to give an idea of publication trends. The aim of these analyses is to position our work in the dynamic context of the existing body of literature.

4.3.3. Category Selection

In this step, we selected the structural dimensions of our literature review and their related analytical categories. The inspiration for the choice of categories came from the existing literature as well as our own analysis.

First, the articles were categorized based on the *context of operation*, which can be either disaster relief or continuous aid work, as presented by Kovács and Spens (2007). In their description, disaster relief is used for sudden catastrophes, mainly natural disasters (earthquakes, hurricanes, tsunamis, floods, etc.) and some rare man-made disasters, such as terrorist acts. Disaster relief is usually mobilized very quickly, and ends relatively rapidly (i.e., less than five years after the disaster). On the other hand, continuous aid is generally a long-term response to a disaster, and can last for up to several decades. It usually focuses more on development aid, and is rarely characterized by an emergency. In general, continuous aid starts in the last phase (i.e., reconstruction) of disaster relief. Holguín-Veras *et al.* (2012) make a similar distinction between regular humanitarian logistics (R-HL) which is concerned with long term assistance and has similarities with commercial logistics, and post-disaster humanitarian logistics (PD-HL) which occurs in the initial response following a disaster and aims at answering urgent needs in chaotic situations.

Second, we used one of the criteria developed by Van Wassenhove (2006), which characterizes the *speed of start* of the disaster, by distinguishing between sudden onset disasters, such as tsunami or earthquakes, and slow onset disasters, such as famine or droughts. Depending on this distinction, the emergency levels of the crises differ, as do the types of logistical response needed.

Third, we used another criterion developed by Van Wassenhove (2006), which is the *cause of disaster*. He differentiates between man-made and natural disasters (e.g., earthquakes, tsunami, cyclones, etc.). Typical relief organizations focus mainly on man-made disasters, such as terrorist attacks, political crises or the consequences of war, which more often occur in developing countries where the government has limited resources to respond to the crisis. In his paper, Van Wassenhove (2006) cites the former Director of Médecins Sans Frontières (MSF) France, who stated that between 1982 and 1994, as much as 97% of MSF's operations dealt with the relief of man-made disasters. On the other hand, natural disasters occur in all parts of the world, for example the earthquake and tsunami in Japan in March 2011. In developed countries, governmental agencies usually respond to the crisis and perform, or at least

steer, the emergency relief activities, with limited participation of local NGOs. Of course, the types of logistical response to these two types of crisis are different, with incomparable levels of resources involved.

As the fourth classification criterion, the *phase of disaster management* was used. All the previous literature reviews use this criterion, albeit with slightly different terminology. We applied the model presented by Kovács and Spens (2007), which differentiates between preparation (i.e., evacuation plans, training, pre-positioning of supplies, etc.), immediate response (i.e., rescue, evacuation, coordinating and delivering supplies, etc.) and reconstruction (i.e., reconstruction of houses and infrastructure, economic development, etc.). Some authors also mention the mitigation phase, which deals with the reduction of the effects of disasters. As this phase cannot be observed in each type of disaster, we decided to include this phase in the preparation phase, because it is also conducted before the onset of a disaster.

The fifth classification we used was the *research methodology*, which is also used by Altay and Green (2006). However, as they review the OR literature in particular, we did not use their categories, which are too specific (i.e., different types of modelling techniques), but rather a more general selection of categories, which is common in operations management (Karlsson, 2008) and supply chain management (Kotzab *et al.*, 2005): simulation and modelling, conceptual research, literature review, case study and survey.

The sixth classification we used was motivated by our theoretical framework presented in Fig. 3.1, and aimed at determining the *situational factor* which is mentioned most in each paper. Such a classification is more complex than the five previous ones, and would be too biased if only performed through the qualitative academic judgement of one single analyst. Therefore, a specific classification methodology was developed, based on the previously mentioned idea of codification of text sections to groups (i.e., situational factors), which could later be evaluated quantitatively, based on the group that appeared most in each paper.

For this, we used the ATLAS.ti software package, which is useful to code and analyse the content of texts. We started our analysis by performing a word count in all 174 papers of our selection. This resulted in a list of over 40’000 words, but we only concentrated on the words occurring five or more times in our selection of papers (12’000 words). We manually screened these words in order to identify those related to one of the situational factors described previously. This process was performed two times independently, in order to ensure that no word was missed, and resulted in a list of 388 keywords, which was further reduced by

combining words with the same root to one single keyword (e.g., “politics”, “political”, “politically”, “politicization”, “geopolitical”, “politician” were regrouped in one keyword “politic”). A prefix was also added to keywords which were not specific enough (e.g., “local supplier” instead of “supplier”). Words with ambiguous meanings were removed from the selection in order to avoid having keywords representing several situational factors (e.g., “environment”, which could be related to environmental issues but also to the business environment, was removed). After this refinement process, 120 keywords were left.

These 120 keywords were then categorized into the four situational factors identified previously. This process was performed independently by three researchers in order to increase the reliability of the categorization. A strong consensus was achieved in this process, as an inter-coder reliability of 88% was achieved (i.e., 88% of the keywords were assigned by all three researchers to the same situational factor) and a Fleiss’ kappa of 0.874, which can be considered as an almost perfect agreement (Landis and Koch, 1977). In case of disagreement, the choice with the highest number of votes was kept. The categorization of keywords into the different situational factors is presented in Table 4.3, together with their absolute occurrence. This choice of keywords and their categorization into different situational factors can be described as an inductive approach, as they were derived directly from the literature. This adaptive approach is similar to Mayring’s “inductive category development” method, in which categories are revised and eventually reduced during the coding activity (Mayring, 2000).

The word count was then conducted again with the final selection of 120 keywords. As the ATLAS.ti software tool gives the possibility to visualize and edit the words included in the count, we removed all words appearing in the bibliography and annexes sections, as well as in the names of authors, addresses, and page headings of articles, in order to analyse only the real content of the papers. Also, a manual screening of the words counted allowed us to remove unrelated words which were counted because of their similarity to our keywords (e.g., “non-governmental” was removed from the “government” keyword, “important” was removed from “import” keyword, etc.).

As an output, ATLAS.ti provided a word count matrix [120 words × 174 papers], with the occurrence of each keyword in each paper. In total, the 120 keywords appear 9233 times in our selection of papers. The lowest occurrence (3) is observed for keywords consisting of two words, such as “local capability” or “developing economy”, and the highest occurrences are observed for more general keywords such as “government” (1063) or “community” (986).

4.3.4. Material Evaluation

In this last step, the literature was analysed and categorized according to the six structural dimensions defined in the previous section, similarly to the classification of papers done by Natarajarathinam *et al.* (2009) in their literature review.

Each article was assigned to the first five structural dimensions based on academic judgement through the reading of abstracts and conclusions. When these parts did not contain enough information to categorize the paper, a more extensive examination of the paper was carried out. There was not much ambiguity in assigning articles to categories in the five first structural dimensions.

For the sixth structural dimension, the determination of the *situational factor* mentioned most in each article, we quantitatively evaluated the results of our keyword count, using an approach suggested by Mayring, who states that "the classification of text sections to (qualitatively) generated categories can be quantitatively evaluated. It can be assessed what kind of category is most encoded" (Mayring, 2002). Such text encoding and subsequent analysis is also proposed by Weber (1990) in his book about content analysis.

Two different processes were used for this quantitative approach. First we analysed the absolute occurrence of each keyword. This was performed through a simple occurrence count of each of the 120 keywords, and allowed us to find which keywords are used most in our selection of papers, in absolute terms. Second, the relative occurrence of the four situational factors was analysed. For this, we summed up the number of times all keywords from a particular situational factor i were assigned in the analysed paper (n_i). Then, we calculated the average occurrence of all keywords belonging to this situational factor in all the publications ($\overline{N}_\iota$). Finally, for each paper we calculated the relative usage (U_i) of the situational factor i by dividing n_i by $\overline{N}_\iota$.

$$U_i = \frac{n_i}{\overline{N}_\iota} \tag{4.1}$$

This means that if keywords from this situational factor were used more than average in an article, U_i would be higher than 1 (i.e., the situational factor is overrepresented in this paper), otherwise it would be smaller than 1 (i.e., the situational factor is underrepresented).

Then, we calculated the same figures for each of the other three situational factors in the same paper, which gave us the relative usage of each situational factor in this article.

Finally, this article was assigned to the situational factor which had the highest relative usage (U_i) of all the situational factors of this article.

$$SITUATIONAL\ FACTOR = MAX\{U_{gov}; U_{socio-eco}; U_{infra}; U_{env}\} \quad (4.2)$$

This methodology of classification therefore allowed us to assign each paper to the situational factor which was relatively most mentioned. It has the advantage of sorting out quantitatively the most used situational factor from the situational factors addressed in each article, and is therefore more objective and precise than if done only by academic judgement.

In order to concentrate the analysis only on the most significant results, papers were excluded from this selection process in the following cases:

- If the difference between the maximal and second highest relative usage (U_i) was less than 0.1, indicating an unclear distinction between situational factors. 23 papers were excluded from the analysis due to this rule.
- If the maximal relative usage (U_i) was below 1, showing that none of the situational factors was overrepresented in this paper. 45 additional papers were excluded from the analysis due to this rule.

For this reason, the analysis of relative occurrence was conducted on a subset of 106 papers.

TABLE 4.2: STRUCTURAL DIMENSIONS AND RELATED CATEGORIES FOR THE CLASSIFICATION OF PAPERS

Structural dimension	**Analytical categories**	**Methodology of assessment**
Context of operation	Disaster relief | Continuous aid | Both or not specific	Academic judgement
Speed of start	Slow onset | Sudden onset | Both or not specific	Academic judgement
Cause of disaster	Natural | Man-made | Both or not specific	Academic judgement
Phase of disaster	Mitigation & preparation | Response | Reconstruction | Several	Academic judgement
Research methodology	Simulation & modelling | Conceptual research | Literature review | Case study | Survey	Academic judgement
Situational factors	Governmental | Socio-economic | Infrastructure | Environmental	Relative occurrence

Table 4.2 provides a list of all the structural dimensions and related analytical categories that were used to categorize the papers of our review, as well as the methodology applied for assigning the papers to the different categories in each dimension.

4.3.5. Quality

As a thorough literature review process is crucial for performing substantive and valid research (Rao and Goldsby, 2009), it is important to discuss quality measures of content analysis, such as objectivity, validity and reliability (Spens and Kovács, 2006). All the steps of the literature collection and evaluation process are precisely described in the methodology section, which increases the transparency and reproducibility of our research design. Objectivity is ensured in the review process by designing clear decision rules for the coding in each category (Spens and Kovács, 2006). The clearly defined classification scheme is mainly based on existing theory, which increases the reliability of the coding and the internal validity of the findings. The use of three researchers for the allocation of keywords to the different situational factors increases the reliability of the categorization process (Spens and Kovács, 2006). External validity (generalization) is assumed because a very broad set of papers was examined, thus we believe that the content we analysed is representative of the field of academic knowledge in humanitarian logistics. A high level of construct validity (i.e., measuring what we want to measure) is achieved for the first five structural dimensions, as all of them are taken from the existing literature and are well accepted in the community. For the sixth

structural dimension – the situational factor most mentioned in each paper – the construct validity is less strong, as these particular set of situational factors were developed inductively and have never been tested before. This was however compensated for by using a highly objective method (automatic word count of specific keywords) and through the use of multiple researchers for allocating keywords to the situational factors. Inter-subjectivity of data analysis was achieved by discussing the ambiguous decisions between the three researchers, with the aim of finding a shared understanding. The significance of the results of the relative analysis of situational factors is increased because we removed papers for which no clear result emerged.

TABLE 4.3: KEYWORDS (OCCURRENCE) ASSIGNED TO EACH SITUATIONAL FACTOR

Governmental (2973)	**Socio-economic (3913)**	**Infrastructure (1528)**	**Environmental (819)**
government (1063)	community (986)	infrastructure (642)	geography (240)
politic (521)	social (635)	road (506)	environmental (178)
law (121)	culture (374)	airport (111)	weather (86)
regulation (107)	women (239)	bridge (74)	climate (83)
legal (101)	gender (195)	highway (45)	tropical (49)
official (87)	society (146)	electricity (43)	rainfall (34)
enforce (83)	poverty (126)	generator (40)	mountain (32)
police (81)	male (119)	railway (29)	forest (24)
restrictions (77)	welfare (110)	utilities (15)	meteorological (24)
customs (74)	urban (102)	subway (13)	pollution (13)
citizens (60)	language (77)	harbour (10)	geophysical (12)
bureaucracy (51)	rural (75)		deforestation (10)
border (50)	female (69)		desert (10)
import (49)	ethnic (64)		ecology (10)
local authority (42)	religion (61)		topography (9)
ministry (40)	Islam (50)		geology (5)
regime (39)	local supply (36)		
democracy (36)	church (30)		
president (31)	psychosocial (29)		
constitution (29)	psychological (25)		
legislation (28)	demographic (23)		
court (26)	microenterprise (20)		
municipal (23)	local economy (19)		
colonial (22)	local partner (18)		
corruption (20)	local sourcing (17)		
coercion (19)	sociology (17)		
jurisdiction (17)	local capacity (15)		
diplomacy (16)	local organisation (15)		
election (16)	Muslim (15)		
justice (15)	strike (15)		
parliament (8)	literacy (13)		
fiscal (5)	local actor (13)		
judiciary (5)	local market (13)		
public administration (5)	local procurement (13)		
national army (3)	local retailer (13)		
repression (3)	local NGO (12)		
	minority (12)		
	adult (9)		
	local staff (9)		
	supermarket (9)		
	anthropological (7)		
	inflation (7)		
	local expertise (7)		
	socioeconomic (6)		
	local manufacturer (5)		
	oligopolistic (5)		
	procured locally (5)		
	local business (4)		
	local personnel (4)		
	local worker (4)		
	developing economy (3)		
	emerging economy (3)		
	entrepreneurship (3)		
	local capability (3)		
	local distributor (3)		
	local production (3)		
	local provider (3)		

4.4. Results

4.4.1. Descriptive Results

By following the methodology described in the previous section, a total of 174 articles written between 1993 and 2011 were retained and analysed. Fig. 4.4 shows a growing trend in the number of publications per year, which justifies the need for an up-to-date literature review. It also demonstrates that humanitarian logistics is a new field of research that has attracted increasing interest in recent years.

This strong increase can be explained by the fact that in the years 2004 to 2006, three major natural disasters happened, and the logistic response suffered from inefficiencies, especially in the case of the Asian tsunami. Acknowledging this, several researchers started to investigate that area.

This increase can also be partially explained by the fact that during the years 2007 to 2011, several journals published special issues focusing on humanitarian logistics, and a new journal on this topic was launched in 2011 (JHLSCM, 2011).

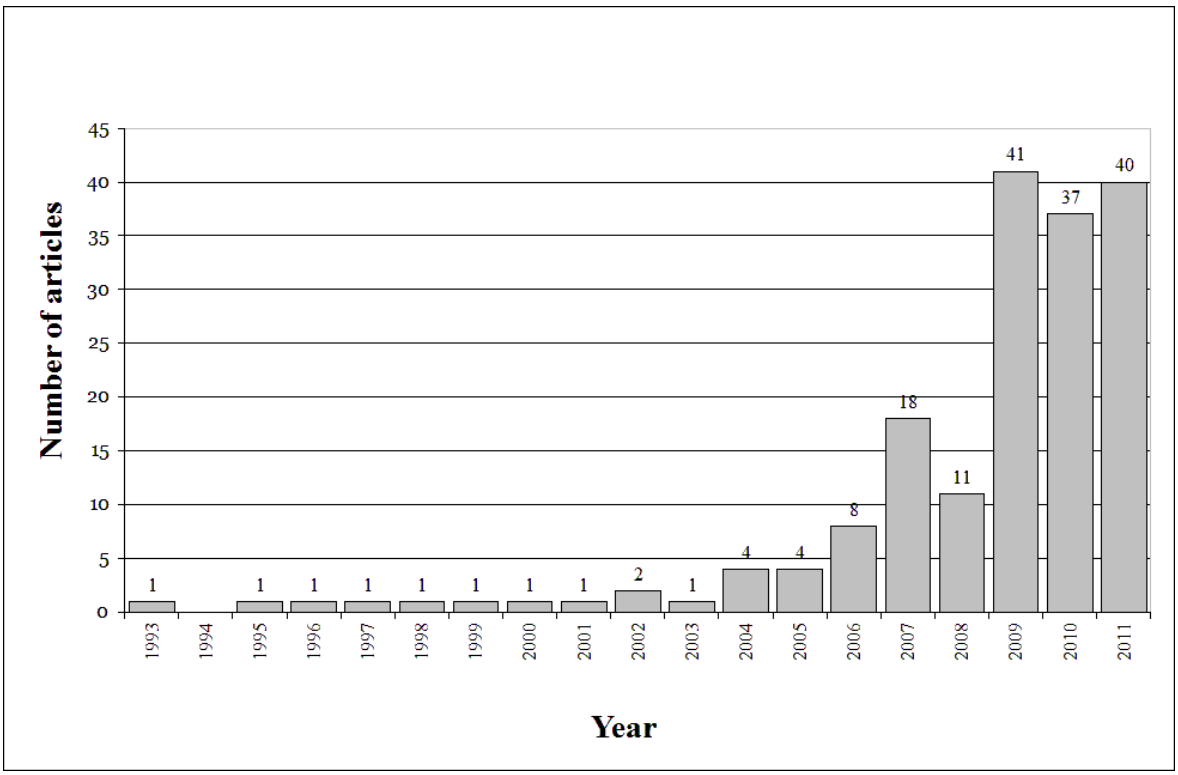

Figure 4.4: Number of articles per year

The number of articles published in the different journals is presented in Table 4.4. The high number of papers published in some of them is due to the publication of special issues on humanitarian logistics.

TABLE 4.4: NUMBER OF PAPERS PER JOURNAL AND TYPE OF PUBLICATION

Title of journal	**Number of papers**
International Journal of Physical Distribution & Logistics Management	22
International Journal of Production Economics	17
Journal of Humanitarian Logistics & Supply Chain Management	9
Supply Chain Forum: An International Journal	8
Transportation Research Part E: Logistics & Transportation Review	8
Management Research News	7
Disasters	6
OR Spectrum	6
International Journal of Logistics: Research & Applications	5
Journal of the Operational Research Society	5
Computers & Operations Research	4
International Journal of Risk Assessment & Management	4
International Journal of Services Technology & Management	4
Supply Chain Management: An International Journal	4
European Journal of Operational Research	3
Transportation Research Record	3
Interfaces	2
International Journal of Logistics Systems & Management	2
International Journal of Productivity & Performance Management	2
Journal of Business Logistics	2
Journal of Public Procurement	2
Transportation Research Part B: Methodological	2
Transportation Science	2
American journal of disaster medicine	1
Annals of Operations Research	1
Asian Journal of Social Science	1
Business Horizons	1
Computers & Industrial Engineering	1
Decision Sciences	1
Development & Change	1
Expert Systems with Applications	1
Fuzzy Optimization & Decision Making	1
Harvard business review	1
IIE Solutions	1
Information Technologies & International Development	1
International Affairs	1
International Journal of Advanced Robotic Systems	1

Title of journal	Number of papers
International Journal of Educational Development	1
International Journal of Emergency Management	1
International Journal of Logistics Management	1
International Journal of Operations & Production Management	1
International Journal of Public Sector Management	1
International Journal of Services Sciences	1
International Journal of Strategic Property Management	1
International Studies Quarterly	1
International Transactions in Operational Research	1
Journal of Business Ethics	1
Journal of Global Optimization	1
Journal of Intelligent Transportation Systems	1
Journal of Manufacturing Technology Management	1
Journal of Multi-Criteria Decision Analysis	1
Journal of Network & Computer Applications	1
Journal of Operations Management	1
Journal of the Association for Information Systems	1
Journal of the Royal Statistical Society. Series C, Applied statistics	1
Knowledge & Information Systems	1
Management Accounting Quarterly	1
MIT Sloan Management Review	1
Naval Research Logistics	1
Operations Management Research	1
Oxford Development Studies	1
Papers in Regional Science	1
Production & Operations Management	1
Science	1
Social Studies of Science	1
The Economic Journal	1
TOP: An Official Journal of the Spanish Society of Statistics & Operations Research	1
Transportation Research Part A: Policy & Practice	1

4.4.2. Results by Categories

In this part, we present the different classifications of the articles of our selection according to the structural dimensions described earlier. All the results are presented in Table 4.5.

For the *context of operation*, a large majority of the papers concentrate on disaster relief (86%). Only 11 papers in the selection (6%) focus on continuous aid aspects.

For the *speed of start*, most articles deal with sudden onset disasters (66%) or both sudden and slow onset disasters (26%). Only 14 papers (8%) concentrate specifically on slow onset disasters.

Concerning the *cause of disaster*, most articles focus on natural disasters (37%) or both natural and man-made disasters (58%). Only nine papers (5%) focuses specifically on man-made disasters.

As for the *phase of disaster management*, 33% of the papers cover several phases. Another 42% focus on the response phase that immediately follows the outbreak of the disaster. The mitigation and preparation phase is covered specifically in 33 papers (19%), while the reconstruction phase, following the response, is studied in depth in only ten papers (6%) in our selection of literature.

Five different *research methodologies* were used in the articles of the selection. Simulation and modelling is by far the most used methodology (46%), followed by conceptual research (24%) and case study (23%). Surveys were used as main methodology in only seven articles (4%), and literature reviews in only five articles (3%).

Through the word count method presented earlier (see Table 4.3), we found that in absolute terms the socio-economic situational factors are mentioned most (3913 occurrences, 42% of all occurrences), followed by governmental factors (2973, 32%), infrastructure factors (1528, 17%) and environmental factors (819, 10%). Table 4.3 shows that some keywords such as "government" or "community" are used around 1000 times in our set of papers. This is due to the fact that they represent concepts mentioned in most of the paper, even in those which do not focus specifically on a particular situational factor. Words such as "politic", "social", "infrastructure", "road" are also mentioned often as they are of central importance in humanitarian logistics. While this absolute occurrence of keywords is interesting, it does not provide enough information to identify the situational factor on which each paper is focusing.

Our quantitative methodology based on the relative occurrence of keywords addresses this limitation. By following the method described in part 4.3.4, we were able to categorize articles into four major *situational factors* (see Table 4.5). We found that the highest proportion of papers focus on infrastructure situational factors (32%), mainly transport infrastructure. The second highest proportion of papers focus on environmental situational factors (26%), mainly weather, geography or pollution. The third highest proportion of papers focus on

governmental situational factors (23%), and address topics such as local government, regulations, customs clearance, etc. The lowest proportion of papers focus on socio-economic situational factors (19%), with topics such as gender, local economy, religion, etc. 68 papers could not be classified with our quantitative method, because the result of our evaluation was not clear enough (i.e., not a clear difference between two situational factors mentioned in the article), or when no particular situational factor was covered in the article (i.e., situational factors mentioned, but none of them was overrepresented, i.e., had an above average occurrence).

TABLE 4.5: NUMBER OF PAPERS PER CATEGORY FOR EACH STRUCTURAL DIMENSION

Dimension and related categories	**# papers**	**Frequency**
Context of operation		
Disaster relief	150	86%
Continuous aid	11	6%
Both or not specific	13	8%
Speed of start		
Sudden onset	114	66%
Slow onset	14	8%
Both or not specific	46	26%
Cause of disaster		
Natural	64	37%
Man-made	9	5%
Both or not specific	101	58%
Phase of disaster management		
Mitigation and preparation	33	19%
Response	74	42%
Reconstruction	10	6%
Several or not specific	57	33%
Research methodology		
Simulation and modelling	80	46%
Conceptual research	42	24%
Case study	40	23%
Literature review	5	3%
Survey	7	4%
Situational Factor		
Government	24	23%
Socio-Economic	20	19%
Infrastructure	34	32%
Environment	28	26%
Unspecified	68	-

4.5. Discussion

This section's objective is to discuss the results presented in the previous chapter following an integrated, holistic approach.

First, for the *context of operation*, the existing literature focuses mainly on disaster relief, with continuous aid being almost entirely overlooked. The reason for this is that continuous aid allows for better planning and continuous improvement activities and seems to be less challenging to manage than emergency disaster relief. Another possible explanation is that continuous aid operations are more complex to analyse as they require a multi-period approach, which is more complex to model. In our opinion, additional research should address issues from the continuous aid setting, such as partnerships with local companies, the inclusion of the aid effort in the economic development of an area, etc. This is confirmed by a recent publication of Kovács and Spens (2011b), who recognize that humanitarian aid is often embedded in long-term development programmes.

Second, regarding the *speed of start* of disasters, the current literature mainly concentrates on sudden onset disasters, with only few papers covering specifically slow onset disasters. Although slow onset disasters such as drought, famine and floods generally allow for more time to react, they can have worse consequences for populations because of their large scale (Long and Wood, 1995, Majewski *et al.*, 2010). Therefore, careful logistical planning and operation is crucial even for responding to slow onset disasters. Hence, we think that future research should explore in more depth the particularities of slow onset disasters, such as wars, droughts or famines, as they have received only very limited attention so far.

Third, regarding the *cause of disaster*, almost all papers (95%) focus either on natural disasters or on both natural and man-made disasters, but only nine articles deal specifically with man-made disasters. This lack of research on man-made disasters is surprising as for some organizations, such as Médecins Sans Frontières, man-made disasters represent a much larger proportion than natural disasters (Van Wassenhove, 2006). Maybe natural disasters are seen as more fatalistic and therefore generate more interest than man-made disasters, which are perceived as preventable (Altay and Green, 2006). The difficulty of accessing areas affected by man-made disasters is certainly another reason why less research has been performed so far on this type of disaster. Also, the higher complexity of man-made disasters (Long and Wood, 1995) complicates research in this field. Another possible reason for this lower proportion of research on this topic can come from the fact that some man-made disasters, such as

industrial accidents, are generally handled by governmental agencies (e.g., armed forces, fire fighters, civil defence, etc.), and are therefore not reported in the academic literature on humanitarian logistics. Based on the high proportion of man-made disasters in relief organizations' programmes, and because of the complexity of such disasters, we suggest that future research put a stronger focus on the humanitarian logistic response to man-made disasters and their particular challenges.

Fourth, concerning the *phase of disaster management*, we found that most of the papers focus on the response, preparation or several phases, but only ten papers specifically address the reconstruction phase. This confirms results from previous literature reviews which also found that there is a lack of studies on the reconstruction phase (Altay and Green, 2006, Kovács and Spens, 2007, Natarajarathinam *et al.*, 2009, Overstreet *et al.*, 2011). While it is true that this phase generates less urgency, it should however not be forgotten that the quality of the logistical activities during this phase strongly impacts on the success of the whole disaster recovery process, especially in terms of sustainability and long-term effectiveness (Beamon and Balcik, 2008, Benson *et al.*, 2001, Besiou *et al.*, 2011, Kovács and Spens, 2011b). We therefore suggest that the long-term sustainability of humanitarian logistics should be analysed in more detail in the future, as mentioned recently by Kovács and Spens (2011a). The integration of humanitarian logistics into long-term economic development – for example through capacity building or local procurement – is another possible topic in this direction, which is also suggested by Kovács and Spens (2011b).

Fifth, the classification according to the *research methodologies* used in the papers shows that most of the papers use simulation and modelling, which confirms findings of previous reviews (Altay and Green, 2006, Natarajarathinam *et al.*, 2009). Only a few articles use empirical research (case studies and surveys represent together 27% of all papers). As emphasized by several authors (Kovács and Spens, 2007, Kovács and Spens, 2009, Kovács and Spens, 2011b, Natarajarathinam *et al.*, 2009, Pedraza-Martinez *et al.*, 2011, Pettit and Beresford, 2009), we think that empirical methodologies such as cross-organizational case studies as well as surveys should be used more in order to increase knowledge in the field.

Sixth, the analysis of the *situational factors* leads to interesting findings. The absolute occurrence of keywords shows that some concepts are used frequently in all publications. The word "government" for example is the most mentioned word, and appears in 73% of the papers, showing the high importance of governments in humanitarian logistics. The word "politic" is

the fifth most mentioned word (521 times), which also confirms the importance politics play in humanitarian logistics, as mentioned by several authors. Tomasini and Van Wassenhove (2004) for example call for a de-politicization of humanitarian supply chains in order to avoid the manipulation of relief aid by stakeholders such as local governments. Kovács and Spens (2011b) as well as Seekins (2009) mention the strong impact of politics on humanitarian logistics, and recommend to include this aspect more in future research on humanitarian logistics.

Socio-economic situational factors are also mentioned in several papers. The keyword "community" for example appears 986 times, and is used in 69% of the papers of our selection. "Social" is also of major importance, and is used 635 times, as well as "culture" which appears 374 times. The high absolute usage of these words shows the importance of socio-economic factors, which is proven by several papers focusing on issues such as gender (Kandiyoti, 2007, Kovács and Tatham, 2009a, Kovács and Tatham, 2010), education (Aguilar and Retamal, 2009) or the implication of local communities in disaster relief operations (Kovács *et al.*, 2010). The low absolute occurrence of keywords such as "local manufacturer" (5), "local business" (4), "developing economy" (3) or "emerging economy" (3) is surprising and shows that these themes are underrepresented in current research, despite their importance in humanitarian logistics.

Infrastructure situational factors are also mentioned often. Obviously, the word "infrastructure" (642 times) appears often (in 71% of all papers), and words such as "road" (506) or "airport" (111) are also used frequently, which is easily understandable as our review focuses on logistics. In a disaster setting, the infrastructure is often destabilised, which strongly impacts the transportation capabilities (Kovács and Spens, 2007, Pettit and Beresford, 2009). Especially in natural disasters, the road infrastructure is often destroyed and emergency repair activities are needed before relief supplies can be dispatched to the beneficiaries (Yan and Shih, 2009). Power supplies are other examples of critical infrastructures which have to be restored in the immediate aftermath of a disaster in order to facilitate the response phase (Oloruntoba, 2010). Airports can also be destroyed by disasters (Pettit and Beresford, 2005) and can represent major bottlenecks which slow down the delivery of supplies during the immediate response phase of a disaster (Tomasini and Van Wassenhove, 2004).

Keywords from the environmental situational factors were used less often than the other situational factors. Indeed, "geography" (240 occurrences) and "environmental" (178), the most used words in this situational factor, appear only in 55% and 31% of the papers. This may seem surprising, but it has to be mentioned that words representing causes of natural disasters, such as hurricane, cyclone, drought, flooding were intentionally not included in our list of keywords, in order to concentrate only on exogenous factors influencing disasters, such as weather, pollution, geography, etc. The low use of keywords belonging to environmental situational factors may be due to the fact that the environment is a rather specific problem, affecting only some particular disasters settings. Thomas and Fritz (2006) mention that disasters occurring on large geographic areas increase the complexity of the logistical response. Geography and weather is also important when solving routing problems (Smirnov *et al.*, 2007) or facility location problems (Görmez *et al.*, 2011). Topography also has a strong influence on the logistics response, as mountainous areas for example are much harder to reach than plains (Balcik *et al.*, 2010, Nolz *et al.*, 2010, Tatham, 2009, Thévenaz and Resodihardjo, 2010).

The quantitative methodology based on the relative occurrence of keywords shows different results than the absolute one, because it aims to identify the main situational factor addressed in each paper. This analysis shows that the share of papers focusing on each of the different situational factors is quite well equilibrated. There are however some differences which we will discuss now.

The infrastructure situational factors are focused on in the highest proportion of papers (32%), which is certainly due to the fact that simulation and modelling problems are generally related to infrastructure, as for example routing problems (Özdamar, 2011, Trautsamwieser *et al.*, 2011, Tzeng *et al.*, 2007), scheduling problems (Hu, 2011, Yan and Shih, 2009) or facility location problems (Görmez *et al.*, 2011, Horner and Downs, 2010, Mete and Zabinsky, 2010). This is demonstrated by the fact that 53% of the papers focusing on infrastructure situational factors use this methodology (compared to 46% in the full selection of papers). Interestingly, conceptual research papers are underrepresented among the papers focusing on this situational factor (6%, compared to 24% in the full selection of papers).

The environmental situational factors are focused on in the second highest proportion of papers (26%). As mentioned earlier, this can be explained by the fact that environmental aspects are rather specific problems, and are therefore focused on only in specific studies. Such papers describe the use of meteorological data for preparing to disasters (Lodree and Taskin,

2009, McCoy, 2008, Taskin and Lodree, 2011), the challenges posed by geographic dispersion of disaster operations (Thomas and Fritz, 2006, Van der Laan *et al.*, 2009, Walker and Harland, 2008) or specific climatic or topographic conditions in the area of operation affecting the disaster response (Benini *et al.*, 2009, Listou, 2008, Tatham, 2009). Interestingly, the mitigation and preparation phase of disaster management is overrepresented in this situational factor (28%, compared to 19% in the full selection of papers), showing that environment data are of particular interest in preparing for a disaster.

The governmental situational factors are focused on in the third highest proportion of papers (23%). Several papers focus on country specific disaster settings (Dadzie, 1998, Seekins, 2009, Seybolt, 2009), on the reliance of relief organizations on governments (Kovács and Tatham, 2009b, Long and Wood, 1995, Stephenson, 2005) or on the problem posed by corruption at the government level (Whybark, 2007). The majority of the papers focusing on this situational factor use conceptual research as a main methodology (54%, compared to 24% in the full selection of papers), which is explained by the fact that governmental factors are conceptual in nature and can hardly be addressed through tools such as simulation and modelling. Case studies are also often represented in this situational factor (32%, compared to 23% in the full selection of papers), as they are particularly useful to study highly complex settings (Stuart *et al.*, 2002).

Although the socio-economic situational factors are mentioned in most of the papers in our selection, the lowest proportion of papers in our selection (19%) concentrate specifically on this factor. Even though socio-economic situational factors play a role in most disasters, they were not often recognized as the most important situational factor impacting humanitarian logistics. Most of the papers focusing on this topic mention the importance of culture in the collaboration inside and between organisations (Altay *et al.*, 2009, Dowty and Wallace, 2010, Maon *et al.*, 2009, Perry, 2007, Sandwell, 2011, Tatham and Houghton, 2011, Tatham and Kovács, 2010). The importance of ethnicity and religion is also mentioned in some studies (Albala-Bertrand, 2000, Altay *et al.*, 2009). Topics such as gender (Kandiyoti, 2007, Kovács and Tatham, 2009a, Kovács and Tatham, 2010) also represent a part of the studies on the socio-economic situational factors, as well as the interactions between humanitarian logistics and the local economy (Herlin and Pazirandeh, 2012, Kovács *et al.*, 2010). Conceptual research is the most used methodology for studying this situational factor (50%, compare to 24% in the full selection of papers). Socio-economic situational factors are also conceptual in nature and can hardly be addressed though simulation and modelling methods. Papers

focusing on the reconstruction phase are overrepresented in this situational factor (15%, compared to 6% in the full selection of papers), because the importance of the socio-economic factors of a country is higher during this phase than during the response phase.

As a conclusion to this discussion section, some limitations of our review are presented. First, the decision to concentrate on academic journals ranked in at least one of the major journal quality rankings may exclude some interesting contributions. The use of multiple rankings and the inclusion of new unranked journals should however reduce this risk and improve the representativeness of our selection. Another possible limitation for the qualitative content analysis of the papers (five first structural dimensions) is that the reading of the abstracts and conclusions may not be totally representative of the full content of papers. This risk is however limited, because we performed a more complete examination when the abstracts and conclusions did not clearly provide the information we needed for our classification. Also, even though content analysis is one of the most objective methodologies existing for conducting qualitative text analysis, it nevertheless involves subjective decisions from the researcher (e.g., academic judgement for classifying a paper in one or the other category), which represents a limitation of this methodology.

The quantitative analysis of the keywords leading to the definition of the most studied situational factor also has some limitations. First, the choice of keywords related to each situational factor may have a selection bias. This risk has however been mitigated by conducting the process independently by three different researchers. Second, the word count method is not able to distinguish the context in which the words are used. Even though keywords with a possible ambiguous meaning were removed, it is still possible that some words were attributed falsely to a specific situational factor. In order to avoid this, a manual screening has been conducted in the selected papers, and when ambiguous keywords were observed, they were removed from the count. Finally, although the four situational factors presented in our theoretical framework were derived from the literature, the validity of these constructs has not yet been measured, and could therefore be further tested.

4.6. Summary

When returning to the research questions presented at the beginning of the section, we see that previously published literature reviews provide useful findings and suggestions for further research. However, only two of them focus specifically on humanitarian logistics. Also, because they were published some years ago, or because they did concentrate on a limited scope, some of these reviews analyse only a limited number of papers. Finally, each of these reviews concentrate on specific aspects of the literature, but none of them covers in particular the situational factors encountered in disaster affected areas, a topic which this study analyses in detail.

We found that the most studied areas so far are relief operations, in particular sudden onset natural disasters, with a major focus on the disaster response phase. Modelling and simulation constitute the most often used methodology. The keywords occurring most often in our selection of papers are related to socio-economic and governmental situational factors, which play a central role in most disasters. However, we found that a similar number of papers focus specifically on each of these factors, in other words that the repartition between the different situational factors studied so far is well equilibrated. There is however a slightly higher proportion of papers focusing specifically on infrastructure as well as environmental situational factors.

Based on our content analysis of the literature, we suggest that more attention be paid to the logistics of continuous aid operations, that more focus be put on slow onset man-made disasters and that the case study and survey methodologies be increasingly used to collect empirical knowledge. We also think that the reconstruction phase and its sustainability should be studied more. Finally, while governmental and socio-economic situational factors are mentioned in most of the papers, we suggest that more specific studies concentrate on these factors in the future, in order to develop the knowledge in this field.

5. The impact of import barriers on humanitarian logistics

Empirical evidence shows that the governments of countries affected by disasters sometimes impose restrictions on the operations of NGOs (Bratton, 1989, Kovács and Spens, 2009, Whybark, 2007). Such restrictions are often influenced by political agendas, which is undesirable as it can strongly affect the ability of relief organizations to respond to the needs of beneficiaries. Tomasini and Van Wassenhove (2004), for example, call for a depoliticizing of relief operations in order to keep them in line with humanitarian principles (neutrality, humanity, impartiality) and reduce the risk of manipulation by different stakeholders. Similarly, Kovács and Spens (2011b) suggest that more consideration should be given to the role of political science in humanitarian logistics. This is also confirmed by Seekins (2009) who, based on his study of Cyclone Nargis, concludes that "*the case of Myanmar shows that treating natural disasters as non-political issues is a mistaken approach.*"

In addition to these governmental influences mentioned in literature, the importance of this topic was also confirmed by practice. Indeed, one humanitarian organization (Organization A), which we know from a previous research project (Schodl *et al.*, 2010), informed us that import barriers affected the efficiency and effectiveness of their humanitarian logistics activities. Different representatives of this organization mentioned that in one particular program (Chad), the organization experienced a three-month delay due to import barriers, which led to an unforeseen additional financial cost of 30% of the budget. According to these staff members, the beneficiaries where directly impacted by the delay and its resulting cost, as the organization had a limited budget and could therefore provide less assistance.

Despite the importance of the topic for both practice and academia, no specific study has yet focused on the governmental situational factors affecting humanitarian logistics (as found in Section 4). In order to fill this gap, this section of the thesis aims to analyse one particular type of politically influenced restriction, namely import barriers which governments can use to restrict the activities of relief organizations, and also to divert foreign aid from beneficiaries (Bratton, 1989, Kalyvitis and Vlachaki, 2012, Long and Wood, 1995).

Through a multiple case study research conducted among four relief organizations at the headquarters level and at the program level in one focus country, Chad, this section tries to answer to the following questions: (2.1) Do import barriers always have a negative impact on beneficiaries? (2.2) If not, under what circumstances can import barriers be beneficial to the beneficiaries? (2.3) How can import barriers be beneficial to the beneficiaries?

(2.4) Why do import barriers impact differently on different relief organizations in the same country? (2.5) What are the characteristics of governments that explain the strength of import barriers and restrictions imposed on relief organizations?

In order to answer these questions, we first present an overview of the relevant theory. Then we present the case study research methodology we used, and situate this section within the broader conceptual research framework developed in this thesis (as presented in Section 3). After this, we present the main results of our analysis based on six propositions that were tested, and discuss the results. Finally, the section ends with a summary of the main findings.

This section is based on a working paper which is currently being prepared for submission to a journal (Kunz and Reiner). An earlier version of this contribution had also been presented at the 17th Working Seminar on Production Economics in Innsbruck, AT (Kunz and Reiner, 2012a).

5.1. Theoretical background

Several authors consider that the impact of the local governments on humanitarian logistics is particularly strong (e.g., Kovács and Spens, 2009, Seekins, 2009, Tomasini and Van Wassenhove, 2004, Whybark, 2007). For example, governments can support the activities of relief organizations through the military (Kovács and Spens, 2007), can coordinate efforts during the relief operation (Oloruntoba, 2010, Tomasini and Van Wassenhove, 2003), and can regulate NGO activities in order to increase their professionalism (Abbey, 2008). On the other hand, governments can also restrict and limit the activities of relief organizations by different means, sometimes closely linked to the political situation in a territory. Some governments use famine as a weapon against civil populations, and try to control and limit the distribution of food (Murray, 2005). In Somalia for example, relief organizations had to use large quantities of food supplies to bribe local warlords, in order to get access to the victims (Long and Wood, 1995). In another case, when Cyclone Nargis hit Myanmar in 2008, the government tried to restrict and control the delivery of relief aid to survivors because it prioritized national state security over human security (Day *et al.*, 2012, Seekins, 2009).

There are also governmental restrictions which are less dependent on the political agenda of governments. The most widely known forms of restrictions imposed by governments are import barriers, which include tariff and non-tariff barriers. While tariff barriers (duties collected

on imported goods) have been reducing during the last two decades, a simultaneous increase in non-tariff barriers has been observed (Wang *et al.*, 2011), resulting from multilateral tariff reduction following the GATT and WTO negotiations (Melo and Grether, 2000). In the field of humanitarian relief aid, non-tariff barriers can, for example, be imposed through long and complex customs clearance procedures, restrictions on the import of specific items such as medicines or telecommunications equipment, or by requirements for specific documentation. Often, humanitarian supplies are partially exempted from tariff barriers; however, literature shows that relief organizations are generally confronted with some forms of non-tariff barriers, and these can have a major impact.

Kovács and Spens (2009) found that the lack of exemption from customs duties on the import of relief items limits the ability of relief organizations to build up warehouses during the preparedness phase. Kovács and Tatham (2009b) consider that the negotiation of customs agreements with governments is a useful step which organizations can undertake in preparation for a disaster, in order to reduce customs clearance delays once a disaster hits. These long delays were also mentioned by Van Wassenhove (2006) who cites the example of the Asian Tsunami in 2004, where one third of the containers with relief items were still blocked at customs five months after the disaster. He states that issues such as getting customs clearance can slow down the initial response phase after a humanitarian crisis. The importance of customs clearance procedures in humanitarian logistics is also recognized by Thomas and Kopczak (2005), who consider it to be a central activity in the humanitarian logistics function. Duran *et al.* (2011) cite political stability and customs regulations as major decision criteria for defining the best location for pre-positioning relief supplies. Long and Wood (1995) give an example of non-tariff barriers in Ethiopia, where relief organizations had to provide certificates of non-radioactivity for the food imported into the country during a disaster relief program. Similarly, during the 2002 food crisis in Southern Africa, food shipments to Zambia had to be suspended by the UN World Food Programme (WFP) because the maize was genetically modified, which was not acceptable for the Zambian government (Tomasini and Van Wassenhove, 2009a). Another form of non-tariff barriers can be observed in fleet procurement. Even though relief organizations usually get a duty-free status, they have to register their vehicles through a long governmental procedure, which may take 3 to 6 months (Pedraza-Martinez and Van Wassenhove, 2012).

In addition to import barriers, governments may use other tools to control and limit the activities of relief organizations. These restrictions will not be covered in detail here, but it is worth

mentioning some of them. Barriers to access for example, either limiting the entry of relief organizations or humanitarian workers, are used in some countries. In Ghana, international relief organizations are only authorized to enter the country once the government has declared a state of emergency (Kovács and Spens, 2009). Following Cyclone Nargis in Myanmar, the government imposed long visa application processes on aid workers (Seekins, 2009). These specific kinds of limitations may be partly understandable, but they dramatically increase the response time in a disaster. Extreme bureaucracy and corruption are other governmental situational factors which influence the logistical activities of humanitarian organizations during disaster relief operations (Long and Wood, 1995, Rottkemper *et al.*, 2011, Whybark, 2007).

This short overview of existing literature shows that governmental influences, in particular import barriers, are relevant problems requiring more attention from academic research.

5.2. Methodology

As presented above, academic literature demonstrates the strong impact of governmental factors, in particular import barriers, on humanitarian operations. However, no empirical investigation has yet corroborated these findings. Based on a single case study as well as other research work (Schodl *et al.*, 2010) carried out with a humanitarian organization confronted with import barriers, we identified situations in which such governmental factors have a strong impact on humanitarian logistics. These initial impressions were by no way sufficient to build theory, and additional empirical data had to be collected in order to confirm our initial findings. However, due to the lack of previous studies focusing on this topic, the study had to be an explorative one, therefore we had to exclude the survey methodology, for which existing variables and relations to test are needed (Forza, 2002). This lack of previous knowledge on the topic justified the use of an exploratory approach such as case studies which give the chance to identify unexpected variables and relationships (Voss *et al.*, 2002). Also, the case study methodology is particularly well fitted for analysing highly complex subjects (Stuart *et al.*, 2002), such as the one of import barriers which include several actors (governments, donors, relief organizations) interacting in different activities (customs clearance, advocacy, fundraising, etc.). Given this high level of complexity and numerous interactions, the issue of governmental factors, in particular import barriers, cannot be studied out of its context and therefore has to be investigated in its natural setting. Case study research methodology allows such in-context analysis (Yin, 2009), in opposition to mathematical modelling for example

where the problem under study has to be isolated and taken out of its context. Case study research also allows to develop theory through observation of actual practices (Meredith, 1998), which is particularly useful in an explorative phase where the relevant theory is not yet known. Finally, this research on governmental situational factors deals primarily with "why", "what" and "how" questions, to which case study research can answer particularly well (Voss *et al.*, 2002).

Based on the reasons presented above, we found that a multiple case study research methodology was the optimal method to be used for our investigation.

This research was conducted using a clearly structured design, based on the available publications on case study research (Barratt *et al.*, 2011, Eisenhardt, 1989, Stuart *et al.*, 2002, Voss *et al.*, 2002, Yin, 2009), in order to ensure quality in terms of reliability and validity and, in the end, to generate theory (Gibbert *et al.*, 2008).

Based on the strong impact of import barriers experienced by Organization A, we decided to conduct an exploratory single case study with this organization, with the aim of investigating this problem more in detail. For this exploratory phase, we analysed the problem encountered by this organization in Chad over a period of nine months, including one trip to the field during which we performed initial interviews with the program manager, the project manager as well as the logistics assistant. We also met with the CEO and the administration manager of the organization during this time, in order to get a wide insight of this specific problem and to design our research accordingly. A meeting was also conducted with the governmental agency responsible for supervising the work of this organization in its country of operation. The impressions gathered during this initial process were triangulated with secondary data provided by the organization, such as activity reports and newsletters.

This initial exploratory phase in Organization A gave us an understanding of the fundamental problem in one, relatively young and small relief organization, but was by no way sufficient to generate a valid theory. Based on findings from literature saying that large firms can overcome costs resulting from trade barriers easier than small firms (Chaney, 2008), we were expecting the size, and indirectly also the age of the organization to play a central role in its ability to deal with import barriers. Therefore, we decided to conduct a larger scale, multiple case study research among longer established and larger relief organizations. For this, we applied a theoretical sampling, where cases are chosen for theoretical and not statistical reasons. Following the polar type sampling approach described by Eisenhardt (1989), who

recommends the selection of four to ten extreme case organizations in order to fill theoretical categories, we chose cases which could replicate or extend our emergent theory. We therefore decided to start our investigation with a total of four case organizations, and to eventually add some more in the event that we had not achieved theoretical saturation, in other words the point where incremental learning from an additional case is minimal. At the end of the data collection process described below, we noticed that we had reached this point as we did not collect much new insights from the last case organization. We therefore decided not to add more cases.

5.2.1. Sample selection

In addition to Organization A, three other relief organizations were identified through a sample selection process based on secondary documents. For this, and according to our initial expectations that age and size of organizations would be important factors, we selected six of the largest and longest established organizations headquartered in Europe which had a current or past program in Chad, our focus country. We asked 12 research assistants to analyze and code activity reports, program reports and newsletter of each of these six relief organizations. These assistants had not been previously involved in the framework development and were not familiarized with the issue of governmental influences and import barriers. This was done in order to increase external validity, as these coders would not be tempted to subjectively over-identify government related problems. These coders were asked to identify situations in which efficiency and effectiveness of humanitarian logistics were affected, within 12 to 14 public documents of each organization. A total of 219 such problems were identified during this process, from 76 secondary documents. Then the assistants had to classify each of these problems into one of the eight categories listed in Table 5.1. This was done individually by three persons on each report, and if the interpretation of the analysts diverged, a consensus was sought through a group meeting among six assistants. In 80% of the identified problems, all three coders independently assigned the same category. This high inter-coder reliability was confirmed by a Fleiss' Kappa of 0.81, which is, according to Landis and Koch (1977), an "almost perfect agreement" between coders.

One of the types of problem identified in reports is labeled "Government", and contains all situations where actions from the local government impacted efficiency and effectiveness of humanitarian logistics. Based on the results of the literature review as well as the strong impact of this issue on efficiency and effectiveness stated by Organization A, we decided to

focus on this category. Table 5.1 confirms the high impact of this problem, as government related impacts on efficiency and effectiveness are the third most mentioned problem by relief organizations, despite the high diplomatic risks involved in making such public statements.

TABLE 5.1: PROBLEMS IDENTIFIED IN REPORTS

Type of problems	Frequency of problems
Safety	32.4%
Infrastructure	18.3%
Government	**14.2%**
Coordination	10.5%
Management	10.0%
Staff	6.8%
Finance	4.6%
Equipment	3.2%

In order to make sure that the phenomenon under study would be "transparently observable" (Eisenhardt, 1989), we selected the three organizations which mentioned the highest proportion of issues related to governments in their official publications, and also fit with our theoretical sampling mechanism presented earlier. These three relief organizations were contacted, and all agreed to participate in this study, in addition to Organization A. Table 5.2 gives a short overview of these four case organizations. Because of the sensitivity of the data we collected, anonymity of the results was guaranteed to the participating organizations.

TABLE 5.2: KEY FIGURES OF SELECTED CASE ORGANIZATIONS

	Org. A	Org. B	Org. C	Org. D
Number of countries of activity	3	80	20	43
Yearly budget, in million USD	2	>500	160	150
State donations	55%	92%	25%	35%
Private and other donations	45%	8%	75%	65%
Number of international staff worldwide	15	2,000	550	300
Number of national staff worldwide	12	10,000	3,700	1,700
Age of Chad program	1 year	30 years	20 years	3 years
Number of international staff in Chad	2	24	35	8
Number of national staff in Chad	10	120	480	50

Organization A is a young organization, working in the response and recovery phases of man-made disasters. It is working in the field of humanitarian mine clearance, and has programs in Africa and the Balkans. This organization employs 15 international and 10 national staff (one program) and runs on a yearly budget of 2 million USD. It has had a presence in the focus country (Chad) since the end of 2010.

Organization B is a longer established organization, working mainly in the response phase of man-made disasters. It operates worldwide, and its mandate extends from assistance to the victims of wars (health services and food) to advocacy and prevention (training of armed forces or diplomatic activities). It has over 2,000 international staff and more than 10,000 national staff, and it runs on a yearly budget of over 500 million USD. It has had a presence in Chad since 1980.

Organization C provides medical emergency services to beneficiaries in the response and recovery phases of man-made and natural disasters. Our analysis focuses on one national section of this organization, which operates in 20 countries, and employs 550 international staff and over 3,700 national staff worldwide. It runs on a yearly budget of 160 million USD, and has had a presence in our focus country since 1990.

Organization D is providing social and medical services to beneficiaries in its country of origin and through programs worldwide. It is mainly active in development aid, but also runs some relief programs in the response and recovery phases of man-made and natural disasters. Our analysis focuses on one section which runs a program at the national level, but also conducts operations in over 40 countries. It employs 300 international staff and 1,700 national staff, and runs on a yearly budget of 150 million USD. It has had a presence in our focus country since 2009.

As can be seen in the second part of Table 5.2, the programs of these four organizations in Chad are different in terms of the independent variables we chose, namely size and age; this therefore allows us to fill the different theoretical categories by Eisenhardt (1989). Indeed, Fig. 5.1 shows that there are two relatively small programs (A and D), but Organization A's is younger than the one of Organization D. There are two large programs (B and C); Organizations B's is older than the one of Organization C.

		Age	
		Younger	Older
Size	Small	**Org. A**	**Org. D**
	Large	**Org. C**	**Org. B**

Figure 5.1: Size and age of programs in Chad

5.2.2. Data collection

The data collection was guided by a structured interview protocol based on our conceptual research framework. We developed questions based on the existing literature on humanitarian logistics, but also included open-ended questions, where the interviewees could express their own ideas. The interview protocol was validated by testing it with Organization A.

The data collection was carried out during the course of three months in 2011. Due to different organizational structures in each organization, we could not interview exactly the same function, so we focused more on having interviewees with similar responsibilities. We tried to have at least one person in charge of logistics, one desk officer (i.e., manager in charge for a specific country/area) and one senior manager. A one page summary describing the aim of the research was sent to each interviewee, however without giving any information about neither the conceptual framework nor the hypothesis we wanted to investigate. We experienced a good cooperation from the interviewees, and one logistic director even organized the interviews with three of his colleagues. Table 5.3 shows the functions we interviewed in each organization, at the headquarters and the field level.

TABLE 5.3: FUNCTION OF STAFF INTERVIEWED IN EACH ORGANIZATION

Org.	Function	Level
A	CEO	HQ
A	Administrative Director	HQ
A	Supply Chain Manager	HQ
A	Institutional Advisor	HQ
A	Program Manager Chad	Field
A	Technical Field Manager Chad	Field
B	Head of Sector Logistics, Central & Southern Africa	HQ
B	Head of Sector Logistics, East and Central Asia	HQ
B	Deputy Head of Delegation Chad	Field
B	Logistics Manager Chad	Field
B	Logistics Assistant Import-Export Chad	Field
C	Logistic Director	HQ
C	Head of Operational Logistics	HQ
C	Head of Supply	HQ
C	Coordinator Procurement Unit	HQ
C	Logistics Coordinator Chad	Field
C	Finance Coordinator Chad	Field
D	Head of Logistics Services	HQ
D	Desk Officer Africa	HQ
D	General Coordinator Chad	Field
D	Logistician Chad	Field
D	Logistics Assistant Chad	Field

The data collection process started at the headquarters level of the case study organizations. At this first stage, top and mid-level executives were interviewed, such as the CEO, administrative manager, logistics manager, supply chain manager, and desk officer. The aim of these interviews was to gather data from potentially all the programs of each relief organization (146 different programs in total). This broad source of data increases the external validity of our research. These interviews were conducted by the main researcher and a research assistant, who was not informed of the conceptual research framework and initial hypotheses.

The second step of the data collection was undertaken in one focus country, in order to control as many external variables as possible and to avoid too many different situational factors that would be problematic in terms of theory building. The aim of this second stage was to collect

more in-depth data in order to understand the full complexity of the phenomenon. Based on the experience of Organization A, we selected a Central African country, Chad, which is still confronted with a major humanitarian crisis caused by political instability on its eastern border, the presence of landmines in the north, and famine and epidemics in the centre of the country. These different crises are currently in the rehabilitation phase, but some emergency programs are still active, such as responses to a cholera crisis or to acute malnutrition. In general, Chad is experiencing relative political stability and its government has the control over the entire territory. Freedom House, a think tank publishing the yearly "Freedom in the World" index (Freedom House, 2010), gives this country a political rights score of 7 and a civil liberties rights score of 6 (7 being the lowest level of freedom). Another source, the Polity IV project (Marshall and Cole, 2011), which yearly publishes an index about the authority characteristics of states in the world, defines the Chadian regime as "autocratic", with a legitimacy score of 10 (12 being the lowest level of legitimacy). The "Corruption Perception Index" published by Transparency International (2011), assigns Chad a score of 2 (where 0 is the highest level of perceived corruption), which ranks it on position 168 out of 182 states. According to our case organizations, import barriers exist in this country, but not at an extreme level. We believe that this setting is ideal to build theory, as an extremely high level of barriers would have reduced the external validity of our findings.

During the data collection in Chad in autumn 2011, we interviewed post-holders such as program managers, logistics managers and logistics assistants in each case organization. Names of these persons were given to us by our interviewees at the headquarters, and contacts were then taken directly with these persons. We used the same interview protocol as for the headquarters, but focused only on the Chad programs.

After transcription, all interview notes were sent to respondents for validation. All but four interviewees answered in order to confirm the validity of our notes, and some of them even did changes in the document. This increases the internal validity of our data, and also shows a high involvement of the respondents in the project.

Throughout the whole data collection process, we ensured a full anonymity and confidentiality of the data collected. All interview transcripts were named with codes, and no recognizable elements were mentioned on them. A signed confidentiality commitment signed by the authors and the research assistant was handed over to each respondent before the interview, in order to make them feel comfortable and allowing them to speak freely about these sensitive

topics. One respondent even acknowledged these efforts after the interview: “We appreciate your understanding of the sensitive nature of some of these elements” (Respondent from Organization B, by email, 08.11.2011). This high confidence increases the validity of the data, as the respondent does not fear that his answers could be communicated to the government or to any other stakeholder. This rigorous process enabled respondents to speak openly about sensitive issues such as corruption, or specific problems with the government.

After validation of the interview transcripts by the respondents, we saved them in our case study database in order to have all data centrally stored and make the information easier to retrieve and analyse later on.

As presented in Table 5.4, five or six people were interviewed in each organization, and there were 22 interviews in total (12 at the headquarters, 10 in Chad) carried out in over 24 hours of interviewing.

TABLE 5.4: NUMBER OF INTERVIEWEES IN EACH ORGANIZATION

	Org. A	**Org. B**	**Org. C**	**Org. D**	**Total**
Interviews at HQ	4	2	4	2	**12**
Interviews in Chad	2	3	2	3	**10**
Total number interviews	6	5	6	5	**22**
Interview time [h]	7h	6h	6h	5h	**24h**

In addition, we also interviewed the Chadian Minister of Territory, Mr. Assane Ngueadoum, as well as the former European Union’s Special Representative for Sudan and Darfur, Mr. Pekka Haavisto, in order to incorporate the point of view of both local and international governmental institutions. These interviews helped us to develop a balanced view of the motivation of governments in imposing import barriers on relief organizations.

In addition to these primary sources of data, secondary data such as activity reports, websites or newsletters were also collected in order to triangulate the findings from the interviews.

5.2.3. Data analysis

As the interview protocol already contained questions on the key variables of interest, extensive coding work for the data analysis was not necessary. Data triangulation between interviewees and an initial interpretation was conducted in each case. Both the main researcher and the research assistant separately analyzed the data, and compared their results. At the time of

the data analysis, the research assistant had only the knowledge gained during the interviews, but was not yet informed about the hypothesis underlying the research, nor the conceptual research framework. We first tried to identify a consensus view arising from all the answers and the secondary data relating to each interview question, and combined it into one consensus statement for each organization. Contradictory answers were identified and listed, and the most often cited answer was taken as consensual for each question. Differences mainly came from the fact that the headquarters interviews covered all countries where the NGO operates, whereas the interviews at the program level concentrated only on Chad. Sometimes differences in responses also arouse because some respondents were less involved in a particular topic, and thus did have only a superficial knowledge of the matter. All such biases were identified and listed in the interview database. In order to keep the full richness of the data, we kept all contradictory statements in a specific field, in order not to lose any information.

After this internal case analysis, a cross-case analysis was performed for all variables in order to identify patterns (Eisenhardt, 1989). Relationships between them were identified, based on the conceptual framework that was initially developed. By testing these relationships for each case, we tried to reject each of our propositions, following Popper's (1959) recommendation. The propositions which could not be rejected were accepted, and these could therefore contribute to building new theory.

5.2.4. Quality

Table 5.5 summarizes the actions that were taken to increase quality of the research according to different criteria, based on literature on quality and rigor in case study research. These actions and criteria are presented in detail below.

Internal validity, also called "logical validity" by Yin (2009), refers to the validity of the causal relationships between the variables and the results (Gibbert and Ruigrok, 2010). Eisenhardt (1989) recommends to link the empirical results with existing literature, in order to enhance the internal validity. We did this by constructing our research framework on a broad body of literature, both from the field of humanitarian logistics, NGO-government relationships, as well as economical literature on trade barriers in development aid. This literature was also included into our analysis and discussion of results. Starting our research with a clear conceptual research framework helped us to have a clear initial idea of the relationship we wanted to test, and thus to increase internal validity (Yin, 2009). We also increased internal validity in our study by seeking convergence between our initially developed propositions and

the empirically observed patterns (Gibbert and Ruigrok, 2010). Following Popper's (1959) critical rationalism, we tried to falsify our propositions with all our case organizations, and only when this was not possible we accepted the proposition. When a proposition could be falsified, we developed a new one which included a new variable.

External validity, often also called "generalizability", refers to the validity of the results in other settings. According to Yin (2009), case studies do not allow for statistical generalization, i.e., inferring conclusions from a sample to a population. However, case studies allow for analytical generalization, what is the generalization from empirical observations to theory, rather than to the whole population (Yin, 2009). Our theoretical sampling mechanism and case selection process aimed at filling theoretical categories (i.e., size, age and type of activities) increases generalizability, as we tried to include different type of organizations. With our four case organizations, we have enough cases to generate theory (Eisenhardt, 1989). Moreover, these organizations gave us access to potentially 146 different programs worldwide. We conducted our interviews until we achieved "theoretical saturation", in other words when the marginal increase of information from each additional interview became minimal (Eisenhardt, 1989), which increases external validity.

Construct validity can be defined as the extent to which constructs are reliably measuring what the researchers want to measure, or the extent to which a research provides a correct observation of reality (Denzin and Lincoln, 1994, Gibbert and Ruigrok, 2010). Following Eisenhardt's (1989) recommendation, we used multiple sources of evidence to measure constructs. For example, the size of case organizations was measured as a combination of different figures such as budget, number of national and international employees. These data were collected during the interviews, and triangulated with figures found from secondary sources of data, which also increases construct validity (Yin, 2009). Using a structured interview protocol for all interviews also improved construct validity, as we received answers from different persons to the same questions. These answers were then compared within the case, and triangulated between each other. When a diverging answer was found, we tried to understand the reasons for these differences, and tried to find one consensual answer. If this was not possible, we noted this divergence in our research database, in order to keep the full richness of the data for the analysis. Triangulation was also facilitated as we conducted the interviews ourselves, which allowed us to collect rich insights into the culture of each organization. This observation led to the development of propositions which were totally unexpected before the start of the data collection process. A clear chain of evidence is another

way to ensure construct validity (Gibbert and Ruigrok, 2010, Yin, 2009), and this was achieved by clearly describing our sampling and data collection process, as well as presenting how we developed our propositions.

Reliability can also be defined as the absence of random error, enabling other researcher to arrive to the same results if conducting the same study again (i.e., repeatability) (Denzin and Lincoln, 1994). Doing a large part of the interviews together with a research assistant which was not informed about the initial propositions increased the reliability. The interviews were tape recorded, and in case of doubt during the write up of the interview transcript, the researchers went back to the tape to check what was exactly said. The interview transcripts were validated by the respondents in order to make sure the interviewers did not misinterpret any answer. The final draft of the paper was sent to one respondent in each organization (generally the most senior respondent), and we asked for the validation of the paper by each organization. Additionally, we proposed these persons to comment the paper, and in one case interesting remarks emerged from the process and could be integrated in the final version of the paper. Our structured interview protocol included several fixed-choice answers, such as five points Likert scales to assess the strength of effects, or specific categories to choose from. The structure given by the interview protocol provided clear structured results, with each answer corresponding to a particular variable. Therefore we could avoid going through an intensive coding work. The within case analysis and subsequent data reduction was performed by the assistant and one researcher, and for the cross case pattern matching, an additional researcher joined the team. According to Silverman (2005), these choices increase reliability of case study research. Gibbert and Ruigrok (2010) state that transparency and replication are the key concepts which ensure reliability. Transparency can be achieved through a precise documentation of how the whole research process was conducted, which we did earlier in this section, by describing in detail our methodology process. Replication is ensured through a well-organized data base, allowing another researcher to retrieve the information easily. In order to ensure confidentiality, we built a first database containing all interviewees' name, organizations, the place and date of each interview, as well as the name of the interviewers. A second database contains all interview transcripts as well as the within case analysis, with no recognizable element. The data are organized so that they are easy to retrieve and analyze, and if needed at a later stage, to be used by another researcher.

TABLE 5.5: ACTIONS TAKEN TO INCREASE QUALITY OF RESEARCH

Criteria	Actions
Internal validity	- Link empirical results with existing literature - Develop propositions based on a conceptual research framework - Seek convergence between propositions and empirically observed patterns
External validity	- Collect data at headquarters, from potentially 146 programs worldwide - Apply theoretical sampling mechanism, filling theoretical categories - Collect data until theoretical saturation is reached
Construct validity	- Triangulate between multiple sources of evidence - Use a structured interview protocol - Maintain a clear chain of evidence
Reliability	- Conduct data collection and analysis with two researchers - Validate interview notes by respondents - Validate final draft of the paper by case organizations - Integrate suggestions from case organizations in final version of the paper - Use a structured interview protocol containing fixed-choice answers - Allow replication through precise documentation of the research process

5.3. Model

The model presented in Fig. 5.2 is based on the conceptual research framework previously developed in Section 3. This model was slightly adapted for this section, as we concentrate only on one particular governmental situational factor, namely the import barriers set by the local governments. The dashed parts in this figure represent constructs and relationships which have an impact but are not covered in this section.

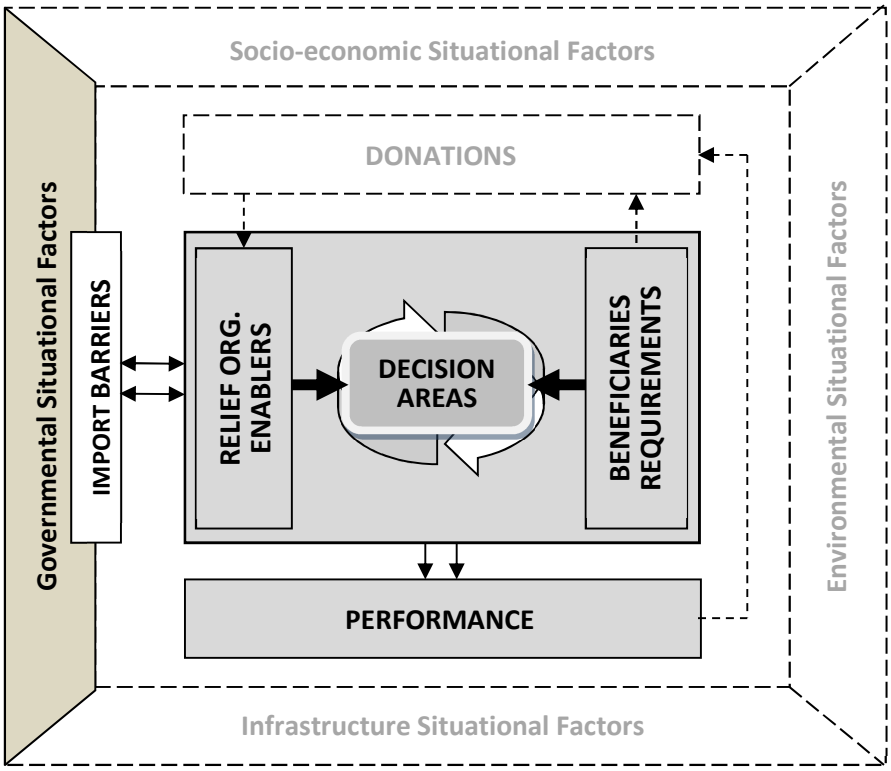

Figure 5.2: Case Study model (based on framework, Fig. 3.1)

We focused on how the imports barriers influence the performance of relief organizations, in other words, on their ability to answer to beneficiaries' requirements with their enablers.

This model enabled us to develop several propositions, which were compared with the empirically observed patterns. We also used this framework to develop the structured case study protocol that guided us through our research.

5.4. Results

The following propositions were developed based on our case study mode, and then tested through the interviews.

5.4.1. [P1.1] Import barriers always have a negative impact on beneficiaries.

This initial proposition came to mind while analysing Organization A. Based on expert opinion from within the organization we found that import barriers have a strong impact on the performance of their operation, in other words on their ability to respond to the requirements of beneficiaries, both in terms of effectiveness and efficiency. Managers of this organization estimated that in the Chad program, they lost 2–3 months and up to 30% of their operational

budget because of import barriers. We tried to replicate this finding in the other case organizations, and found some evidence supporting the proposition, however at very different levels, as can be seen in Table 5.6. On a five-point Likert scale, Organization A evaluated the impact of import barriers on effectiveness and efficiency at 4 and 4.2 (strong); Organization B evaluated it at 2.2 and 1.8 (weak); Organization C at 2.6 and 3.1 (moderate); and Organization D at 3.1 and 3 (moderate). Based on these results, we conclude that import barriers have an impact on the performance of operations. For example, the time spent dealing with import barriers (e.g., customs clearance) and the money spent by relief organizations in paying duties leaves less time and money for satisfying the requirements of the beneficiaries. Therefore, there is clearly a negative impact on beneficiaries.

TABLE 5.6: IMPACT OF IMPORT BARRIERS ON PERFORMANCE DIMENSIONS: AVERAGE (RANGE OF ANSWERS)

Impact on … 1: no impact 5: very strong impact	**Org. A**	**Org. B**	**Org. C**	**Org. D**
Effectiveness	4 (3 – 5)	2.2 (1.5 – 4)	2.6 (2 – 3.5)	3.1 (2 – 4)
Efficiency	4.2 (4 – 5)	1.8 (1 – 3.5)	3.1 (2 – 4.5)	3 (3)

Several statements from respondents confirm this negative impact of import barriers on the relief organizations' ability to respond to the needs of beneficiaries. However, there are also answers pointing to the positive effects of these barriers for the protection of the beneficiaries. When speaking about the case of Ethiopia, the coordinator of the procurement unit of Organization C said that "the FMHACA *[food and medicines regulation authority]* set specific regulations in terms of importation of medicines in 2004, after experiencing that a lot of low quality and expired medicines were sent to Ethiopia in the past." This opinion is shared by respondents from other organizations, such as the head of one logistics sector at Organization B, who was of the opinion that, "Governments may want to legitimately protect their population, for example by restricting the importation of GMO food." This point of view was also confirmed by the Chadian Minister of Territory: "For humanitarian supplies, our motivation is mainly to control the quality of the goods which are imported, to make sure that they do not cause health problems to our population." Protection of the local economy is also mentioned by interviewees from Organizations B, C and D. According to the logistics director of Organization C, one of the reasons for governments to impose non-tariff barriers is to make sure that imported items correspond to national standards known to the population and which

the national professionals are able to use, and that these are labelled in the official national language(s).

Although import barriers have a negative impact on the effectiveness and efficiency of humanitarian logistics operations and in turn on beneficiaries, various statements from relief organizations and from the Chadian government clearly demonstrate that import barriers can have positive effects in some circumstances. Therefore, we have to reject our first proposition, and will try to develop a more specific proposition.

5.4.2. [P1.2] During the immediate response phase of a disaster (short term), import barriers have a negative impact on beneficiaries.

In case of an emergency, during or right after a large scale disaster, the needs of beneficiaries are so large that only a major response from international relief organizations can help alleviate the sufferings and reduce the number of affected persons. In the case of Haiti for example, where the government as well as the local relief organizations were themselves affected by the earthquake, only organizations with external resources could bring in the assistance needed by the victims. In such a case, the speed of the response is crucial, and each hour lost has an impact in terms of the number of victims.

With a delay of two to three months due to import procedures in Chad, Organization A can be considered an extreme case, and this was due to the fact that it was its first ever importation process into this country. Organization B mentioned a physical importation process time (time the goods stay in custom) of three days to two weeks on average, and Organizations C and D reported a physical importation process time of one to three days. In most countries, the government allows relief organizations to go through a "pre-clearance process", for which they prepare all documents before the goods are shipped, and thus avoid perishable goods being blocked at customs. While such options are useful in the rehabilitation phase of a disaster, they are not helpful during the immediate response phase. Indeed, the total lead time of the entire clearance process has to be considered during the immediate response phase, in other words, the time needed from first requesting the import authorization until the goods are delivered in the country concerned. According to the head of logistics services of Organization D this "whole import process usually takes three to four weeks." Such clearance process lead times are much too long in an emergency setting, where each hour counts in reducing the number of victims. This problem was confirmed by the head of operational logistics of Organization C, when he said that, "In standard operations *[i.e., non-emergency]*, when you

place an order, you plan the lead time with consideration to the time needed for importation, so the custom clearance does not have an impact. However in emergency operations, the impact is quite high." The logistics director of the same organization stated that, "When we are in an emergency setting, it can be problematic if there are no previously established relationships with authorities. In such a case, it can easily take two to three weeks until the goods are through customs."

In addition to these results, we considered again all the positive effects of import barriers mentioned earlier, and used them to test our new proposition. First, the problem of protecting the population is still relevant, but has however to be balanced with the survival rate of beneficiaries during the immediate response phase. In our opinion, the speed of delivery of food or medicines, which enables a higher survival rate, is more important, on the assumption that a post-emergency customs clearance process is performed after the immediate response phase is over. Also, the motivation to protect the local manufacturers obviously has no positive impact in the immediate response phase. In any event, strong peaks in demand in this phase cannot be covered by local producers, who are sometimes also hit by the disaster themselves. Finally, in a case of emergency, standardization is of secondary importance to the massive needs of the beneficiaries.

Based on the interviews with experts from our case organizations, we could not find any situation where keeping import barriers had a neutral or positive impact in the emergency response phase. Thus, we cannot reject this proposition.

5.4.3. [P1.3] During the rehabilitation phase of a disaster (medium to long term), import barriers have a positive impact on beneficiaries.

In the rehabilitation phase following a disaster, when relief organizations have a much longer planning horizon than they had during the emergency response phase, the negative effect of barriers in terms of delays is almost non-existent. This is because the time needed for customs clearance is integrated into the total lead time, and the previously mentioned pre-clearance process allows relief organizations to reduce the physical importation process time to less than one day. This pre-clearance process is similar in its effects to the inspection of containers at the point of origin and the early electronic submission of shipment information, which guarantee higher supply chain security at lower costs (Lee and Whang, 2005).

In addition to the positive effect discussed earlier (i.e., the protection of beneficiaries), import barriers can also contribute to protecting the local economy, as they encourage relief

organizations to locally purchase the goods they need. This is beneficial in three ways. First, it strengthens local supply chains and existing businesses. Second, it increases the likelihood that the relief items correspond to the requirements and needs of the beneficiaries. Finally, it forces relief organizations to use standardized items, with which the local professionals are familiar, and which can be maintained in the long term, once the foreign staffs have departed.

However, protectionism is often misused, especially when the barriers favour one individual company or person instead of benefiting the whole industry. This was confirmed by the deputy program manager of the Chad program of Organization B who thinks that some import barriers "are more driven by individual interests of some persons working for the government." The head of supply of Organization C holds the opinion that local governments set restrictions on the importation of specific products in order to "favour a local producer who is a friend of somebody in the government." In the cases described by these respondents, the local market is often dominated by one or a very small number of monopolistic local manufacturers or wholesalers that are close to the government and benefit from the import barriers by reaping large profits. In these conditions, large volumes purchased by relief organizations can lead to an inflationary pressure on local prices. In such situations, import barriers create strong market distortions and are obviously not positive for the local economy and beneficiaries. In addition, import barriers on medicines also negatively impact beneficiaries, even during the rehabilitation phase. The coordinator of the procurement unit of Organization D estimates that in Ethiopia, the future restrictions on importation of medicines recently announced by that government will allow the organization to "bring in only approximately 30% of the medical products required for our operation. In the worst case, if we cannot find any agreement with the government, we would even have to close the program."

These examples clearly show that even in the long term, import barriers do not always have a positive impact on beneficiaries; therefore, we have to reject this proposition, and develop a new one with more conditions.

5.4.4. [P1.4] In the rehabilitation phase of a disaster (medium to long term), import barriers on non-medical items have a positive impact on beneficiaries if there is a competitive local market able to provide these items at the right quantity, quality and price.

Based on the findings and the rejection of the last proposition, we added additional conditions to our proposition. First, this proposition was limited to non-medical items, as medicines found locally do not always comply with the relief organizations' internal quality

requirements. In addition, medical supply chains have numerous specificities; therefore we decided to exclude medical items from this proposition. Indeed, import barriers on medicines must be aligned with import barriers on medical production equipment and medical ingredients, otherwise local manufacturers of medicines would face unfair competition from finished medicines imported free of duty (Yadav, 2007). Also, differential pricing applied between low-income and high-income countries require a strong means (e.g., import/export controls) of preventing medicines from flowing back from low price to high price markets (Yadav, 2010).

The second condition for our proposition is that there should be a competitive local market, which is able to provide the items needed by humanitarian organizations at the right quality, quantity and price. According to Samuelson and Nordhaus (2009), a competitive market can be defined as a market in which prices and quantities exchanged are defined as equilibrium of supply and demand, where no firm is large enough to affect the market price. Such a situation arises when the number of sellers and buyers is large and the products sold are homogenous (Samuelson and Nordhaus, 2009). These assumptions are very strict, and we are aware that in most disaster affected countries such conditions are rarely encountered. Nevertheless, under these conditions, and only for non-medical items, we expect import barriers to have a positive impact on the country's economy in the long term, and in the end also on beneficiaries, as they contribute to protect and reinforce the disaster-affected local economy. Indeed, the volume of importations will decrease due to import barriers, and a higher share of goods will be purchased from the local market (Melo and Grether, 2000). When asked about the benefits of local procurement, respondents from each organization said that it allowed them to avoid import barriers. For example, one head of sector logistics at Organization B stated that local procurement is "much faster because there is no transport and no custom clearance needed." The logistics coordinator for the Chad program at Organization C said that local procurement "costs less than to import, because of the import duties." Based on these and similar statements from each organization, we conclude that import barriers provide a strong motivation for relief organizations to procure locally. The logistics director of Organization C explained that during recent years there has been a trend towards more local procurement, because "the market changed a lot, and now you find more available products everywhere." This statement shows that relief organizations are ready to adapt their procurement policies and switch to local supplies when the appropriate conditions and incentives are in place.

Where import barriers encourage relief organizations to purchase locally, local industries and supply chains get stronger and the market becomes more competitive. On the condition that there is a free and competitive market, and therefore low inflationary pressure induced by local procurement from relief organizations, this positive development will eventually have a positive impact on beneficiaries in the long term, as their dependency from foreign suppliers is reduced. Developing countries hit by disasters often have underdeveloped industries, and import barriers can help to temporarily protect and develop them, for the benefit of the economy and the population.

As all of our case organizations have stated, import barriers act as a motivator to purchase non-medical items locally, and because we could not find any contradictory evidence from the interviews, we cannot reject this proposition, under the specific assumptions we made.

5.4.5. [P2] Import barriers have the strongest impact during the initial setup phase of a humanitarian relief operation

Our investigations at Organization A showed that the program they started at the end of 2010 in Chad was strongly impacted upon by import barriers and bureaucracy. Because of these factors, the program experienced a delay of two to three months, inducing additional costs of up to 30% of the operational budget. Different reasons were identified for this strong impact; among them were import barriers on equipment, registration of the organization in the country, strict labour laws, difficulties in obtaining registration plates for the vehicles, and so on. For example, the Chad program manager of Organization A explained that import barriers "had a very strong impact […]. We had for example to travel three times to the border to try to unlock the situation during the importation process." According to the administrative manager, the delays induced by these barriers affect the beneficiaries, because "we have less time available to perform the real work, as we cannot compensate for delays by working an additional period of time (budget is fixed and cannot be extended)." After our interviews with the other organizations, we realized that this pattern was however not generalized, as all three other case organizations mentioned only limited delays due to import barriers in this country (0–14 days for Organization B, 0–3 days for Organization C, and 0–2 days for Organization D). However, we found that Organization D, whose program in Chad started in 2009, experienced similar problems during the year they became established in Chad. According to the desk officer in charge of this program: "In Chad, the set-up of the program was long and complicated, and we lost a lot of time because of all bureaucratic steps we had to undergo

before starting our work. But afterwards, once all these documents and agreements signed, the collaboration with the governmental agencies was OK."

When comparing these patterns of response with the ages of the programs listed in Table 5.2, we found that import barriers seem to have less impact on longer established programs than on younger programs such as Organization A's program, which was still in its first year of operation when the research was conducted, or the program of Organization D in 2009. From our sample of four programs in Chad, we did not find any evidence that contradicted our proposition.

5.4.6. [P3] Fragile states tend to impose more import barriers and other restrictions on relief organizations than other states

For the third proposition, we tried to understand the reasons why governments impose import barriers and other restrictions (such as access barriers, extreme bureaucracy, and extreme control of activities) on relief organizations. According to Atack (1999), cooperation with democratic states, which accept the autonomy and independence of NGOs, is generally easier than with authoritarian states, which see them as enemies of political stability. Based on this finding from development literature, we expected governments with a lower level of democracy to be more suspicious of relief organizations, and to impose more restrictions than other governments. In order to test this idea, we listed (in Table 5.7) all countries where respondents mentioned import barriers and other governmental restrictions, together with a set of indices (political, corruption and business regulation scores) and the average number of restrictions reported in each country. The types of restrictions encountered by each organization in some of these countries are listed in Appendix C.

TABLE 5.7: POLITICAL, CORRUPTION AND BUSINESS REGULATION SCORES OF STATES WHERE CASE ORGANIZATIONS WERE CONFRONTED WITH IMPORT RESTRICTIONS

	POLITICAL			CORRUPTION	REGULATION	Average number of restrictions
Country	Polity State Fragility	Polity Score (Democracy)	Freedom House Status	TI Corruption Perception	WB Ease of Doing Business	
Somalia	25	-	Not free	1	-	2
Sudan	24	-2	Not free	1.6	135	2
DRC	23	+5	Not free	2	178	2
Myanmar	22	-6	Not free	1.5	-	2.3
Chad	22	-2	Not free	2	183	1.8
Ethiopia	21	+1	Partly-free	2.7	111	2
Liberia	18	+6	Not free	3.2	151	2
Cameroon	16	-4	Not free	2.5	161	1.5
Pakistan	15	+6	Partly-free	2.5	105	1
India	13	+9	Free	3.1	132	1
Colombia	12	+7	Partly-free	3.4	42	1
Tanzania	12	-1	Partly-free	3	127	1
North Korea	10	-9	Not free	1	-	1
Senegal	9	+7	Partly-free	2.9	154	1
Israel	8	+10	Free	5.8	34	1
Georgia	8	+6	Partly-free	4.1	16	1
Russia	7	+4	Not Free	2.4	120	1
Bosnia	5	-	Partly-free	3.2	125	1

(Libya not shown because of regime change in 2011)

Four indices were used as proxies for the governmental situational factors. On the political side, we used the Polity IV dataset (Marshall and Jaggers, 2002), and the Freedom in the World classification (Freedom House, 2010), which according to Howard and Roessler (2006), are the best existing indices of democracy and the political environment, and cover most countries of the world each year. In addition, we also used the Corruption Perception Index developed by Transparency International (2011), which describes the perceived corruption level of the government, ranging from 0 (country perceived as highly corrupt) to 10 (country perceived as very clean). We also analysed the business regulatory environment in the different countries, for which we used the Ease of Doing Business index published by The World Bank (2012), which ranks 183 countries according to how favourable the regulatory environment is for starting and operating a business.

While we found evidence that autocratic (non-democratic) states tend to impose more import barriers and other restrictions on relief organizations, there were also countries which contradicted these findings such as North Korea and the Democratic Republic of the Congo (DRC). We then tested if the level of corruption in a country could explain the number of import barriers. Again, there was some evidence for this, but there were also examples contradicting this (e.g., North Korea, Pakistan, Liberia), and it was not possible to derive any firm conclusion from this factor either. We also found some evidence that the business regulatory environment

could explain the level of restriction imposed on relief organizations, but again there were states which contradicted this (e.g., Ethiopia, Senegal, India).

We found a stronger explanation when the number of import barriers and other restrictions in each country was compared with the Polity State Fragility Index (Marshall and Cole, 2011), and this allowed us to develop our third proposition. According to this Index, which ranges from 0 (no fragility) to 25 (extreme fragility), state fragility can be defined as a combination of state effectiveness and state legitimacy (Marshall and Cole, 2011). When comparing the State Fragility Index scores for each country (Table 5.7, first column) with the average number of restrictions (Table 5.7, last column), we can see that fragile states clearly tend to impose more import barriers and other restrictions on relief organizations than states with lower fragility scores. In order to test this proposition, we tried to identify a state in the sample that diverged from this pattern, but there was no state with a fragility score of over 20 with fewer than 1.8 restrictions. Also, no state with a fragility score equal to or lower than 15 imposed more than one restriction. Based on the absence of contradictory evidence, we conclude that in our sample of countries, fragile states (low effectiveness and legitimacy) tend to impose more import barriers and other restrictions than states which are less fragile.

5.5. Discussion

Through our first set of propositions, we analysed the impact of import barriers on humanitarian logistics, and in the end on beneficiaries. We found that this impact is ambiguous, as it is negative in the immediate (short term) period after a disaster but can be positive in the medium and longer term, under some circumstances. The phases of disasters (mitigation, preparedness, response, and rehabilitation) seem to be closely linked with this phenomenon. Indeed, we found that import barriers negatively affect the performance of relief organizations (and in turn, beneficiaries) during the response phase, as customs clearance can create long delays in the delivery of goods, which confirms previous findings (Van Wassenhove, 2006). This phenomenon is intensified for organizations which did not prepare themselves during the preparedness phase, for example by negotiating customs agreements (Kovács and Tatham, 2009b) or by pre-positioning supplies in the country (Kovács and Spens, 2009, Salmerón and Apte, 2010). This negative impact can be mitigated when governments declare a “state of emergency” in order to temporarily lift import barriers and allow relief organizations to conduct the custom clearance process later. During the rehabilitation phase (e.g., long term

reconstruction of infrastructure, capacity building, institutional development) import barriers for non-medical items can have a positive impact on the local economy, if the local markets are free and competitive.

Even though it is widely accepted that trade liberalization increases the wellbeing of countries (e.g., Krugman and Obstfeld, 2006, Melo and Grether, 2000, Samuelson and Nordhaus, 2009), we motivate the positive impact of import barriers on the local economy by the "infant industry protection" concept first developed by List (1904) and Mill (1909). This argument justifies temporary import barriers aimed at protecting an infant industry in a country until it is developed enough to compete on the international market. While it has been criticized by some authors (Baldwin, 1969), this concept is still relevant and accepted in recent development literature (e.g., Lall, 2001, North and Cameron, 2000). This principle, which has been used as an industrialization policy in developing countries, is justified only if the increase of wellbeing achieved after the protection period is higher than the loss of wellbeing during the protection (Melo and Grether, 2000). Such outcome can for example be achieved when a specific industry has to follow a learning curve until it is competitive on the world market, and cannot acquire the required know-how through investments (in presence of imperfect capital markets) (Melo and Grether, 2000). Also, the appropriability argument for infant industry protection states that a new industry may generate social benefits for the future (i.e., creation of knowledge or a new market) for which the pioneering companies are not compensated, therefore justifying temporary protection (Krugman and Obstfeld, 2006). The downside of the infant industry protection is however that most developing countries have not specified a time limit until when using this mechanism, which reduces its potential positive effect (Krugman and Obstfeld, 2006, Melo and Grether, 2000).

Another motivation found in economics literature is that import protection may help to increase employment during a period of recession (Samuelson and Nordhaus, 2009). The observation that labour intensive sectors tend to be more protected than capital intensive sectors (Grether *et al.*, 2001, Rodrik, 1995) may be a demonstration of this motivation to use import protection as a way to safeguard employment.

This positive effect of import barriers can also be linked with Abbey's (2008) findings that government regulation can stimulate particular behaviours among NGOs (e.g., professionalism, stronger coordination). Indeed, the presence of import restrictions can encourage relief

organizations to procure goods fulfilling the national standards, which increases the long term sustainability of humanitarian operations.

For our second proposition, the reasons why different organizations confronted with the same import barriers experience more or less impact were investigated. We were initially expecting the age and size of the organization to play an important role in its ability to cope with import barriers. However, this could not be validated by our results, but we did find that humanitarian programs are much more strongly impacted upon by import barriers during the initial set-up phase of the program (1-2 years) than once the program is well established. While this difference is also observable in standard business logistics, the phenomenon has much higher amplitude in humanitarian logistics, because rules and guidance for customs clearance procedures are often non-existent. Therefore, "trial and error" often seems to be the only way for relief organizations to learn how the process works, which takes an extremely long time and exposes staff to high levels of stress. According to Gonçalves (2011), such stress leads to lower staff retention, and in the end loss of knowledge for the relief organization. Of course, the business regulatory environment of a country has a strong impact on the difficulty faced by relief organizations in starting their operations. This is confirmed by the Ease of Doing Business index (The World Bank, 2012), which ranks Chad, where we conducted the comparison at program level, at the lowest position worldwide (183).

For our last proposition, we tried to identify which characteristics of governments explain the level of import barriers and other restrictions they impose on relief organizations. We could not confirm our initial expectation that the democracy level, the corruption level of a regime, or the business regulatory environment would be the factors which adequately explained the number of barriers and other restrictions. However, we found that state fragility, a combination of the effectiveness and legitimacy of a government, explains the number of import barriers and other restrictions; in other words, the more ineffective and illegitimate a regime is, the more it tends to impose import barriers and other restrictions on relief organizations. This can be explained by the fact that such regimes face a higher risk of being overthrown, resulting in fears that autonomous organizations will challenge their political control (Coston, 1998). As a consequence, such regimes therefore impose stronger controls on the activities of relief organizations. This is confirmed by Bratton (1989) who found that a government with a low political legitimacy will be less permissive toward the voluntary sector. According to this author, such governments often control relief organizations through multiple tools (registration of NGOs, customs clearance, security clearance) and different government units.

5.6. Summary

The objective of our research was to study the effect of import barriers on the performance of humanitarian logistics, and how they impact on the beneficiaries of relief aid. We found that this effect is ambiguous. These barriers always impact negatively on beneficiaries during the immediate response phase of a disaster (short term), mainly because they create delays in the delivery of relief items, through long customs clearance processes. However, during the rehabilitation phase (long term), these import barriers can have a positive impact on the local economy and the beneficiaries, if they are imposed only on non-medical items, and if the goods are available in the right quantity, quality and price on a competitive and free local market. Under these specific conditions, import barriers have a positive impact on the development of the economy of the country (infant industry protection). This in turn reduces the dependency from foreign suppliers and increases the standardization of relief items, which leads to more sustainable relief efforts. We also found that import barriers have the strongest impact during the set-up phase of humanitarian operations, as relief organizations have to follow complex bureaucratic processes and learn how to cope with the import procedures. Finally, we found that the fragility of a state (ineffectiveness and illegitimacy) is the characteristic which best predicts the level of import barriers and other restrictions imposed on relief organizations.

Based on our results, we give some practical recommendations. First, we find that recipient governments should adapt their import-related policies, and include a specific mechanism allowing a temporary lifting of import barriers in the event of disaster. During the rehabilitation phase, they should allow relief organizations to use a pre-clearance process, and remove import restrictions on medical items, requiring only medicines to be certified by a major regulatory authority (e.g., WHO, USFDA). We recommend that relief organizations should address the issue of import barriers in their preparedness efforts, and consider the differing effects of import barriers at different stages of disaster response. We encourage relief organizations to increase the amount of local procurement, under considerations of the positive and negative effects on the local markets. Because import barriers affect relief organizations most seriously during the set up phase of a program, we recommend that relief organizations should negotiate customs agreements in advance with governments of countries prone to disasters. Relief organizations should also allocate more staff to the set-up of new programs, in order to accelerate the learning curve so that they can be operationally effective more quickly. Finally,

knowing that fragile states tend to impose more barriers, relief organizations should be prepared to put more effort in when preparing to enter such countries.

As far as the limitations of our research are concerned, even though we collected data from potentially all programs of our four case organizations, the in-depth analysis of the particular context is limited to one country, which limits generalization to other contexts. In addition, we focused our research on a number of key variables, but cannot exclude the possibility that there are additional factors which could be relevant too. Also, the fact that we concentrated mainly on import barriers may hide other issues relevant to the influence of governments on humanitarian logistics. Finally, some of the assumptions made in this section are rather strict (e.g., competitive markets), which reduces the validity of some of our findings in the context of developing economies where competitive markets are rather unusual.

Further investigation could expand this research to medical items as well. Further research could also analyse whether import barriers during the rehabilitation phase also produce additional positive side effects on the humanitarian operation, such as the reduction of transportation and storage costs. Finally, the customs clearance process could be analysed through a modelling tool, as will be presented in the next section.

6. Pre-disaster investments in preparedness

As mentioned earlier, each year millions of people are affected directly by the consequences of disasters, and their survival depends on disaster relief assistance provided by governments and international relief organizations. This assistance must be provided within the first hours following the occurrence of the disaster in order to increase the survival rate of the affected populations. The first priorities are to locate the victims (e.g., in the case of an earthquake), provide health care to the injured victims, and provide water, food and shelter to the survivors. Such tasks require complex logistical activities, as the needed supplies are rarely available directly at the location where the disaster struck. These logistical activities are hindered by several barriers, such as destroyed transport and communication infrastructures, custom clearance procedures, and operational bottlenecks at key access points, such as airports, harbours or border crossings. Also, when disasters strike in developing countries, relief organizations may be faced with additional challenges. As described in Section 5, the local government does not always cooperate with the international relief organizations and imposes strong import barriers. The uncertainty of the demand poses another challenge to relief organizations, as the exact data related to the number and location of victims is unavailable during the first hours following the disaster (Tomasini and Van Wassenhove, 2009a, p.49).

In order to speed up disaster relief assistance and increase its effectiveness, and thus to reduce the impact of disasters worldwide, academics and practitioners have increasingly called for implementing disaster preparedness (e.g., Duran *et al.*, 2011, Gatignon *et al.*, 2010, Jahre *et al.*, 2009, Kovács *et al.*, 2010, Perry, 2007, Van Wassenhove, 2006). This preventive phase of disaster management can be defined as all of the activities that can be performed by the population, the government and relief organizations before a disaster strikes, with the aim of decreasing its potential devastating effects (Van Wassenhove, 2006). Such preparation efforts and the related uncertainty about the occurrence of unfavourable events are well established in traditional risk management fields (e.g., financial services). However, in the field of humanitarian aid such proactive risk-hedging actions are considerably hampered, since donors traditionally only finance response efforts once a disaster has occurred (Jahre and Heigh, 2008).

The most well-known form of logistical disaster preparation suggested by the literature is the pre-positioning of relief supplies in countries prone to disasters (see Table 6.1). However, this is problematic, because pre-positioning requires high investment costs at various locations, due to the high levels of uncertainty about the timing and location of the next disaster.

In addition, product expiry is a major problem, as there is no inventory turnover between crises (Whybark, 2007). For these reasons, rather than pre-positioning supplies, Van Wassenhove (2006) proposed that relief organizations prepare themselves by investing in effective disaster management capabilities, such as human resources, knowledge management, process management, resources and community. Investing in such capabilities, rather than in physical pre-positioned assets, has several benefits. First, in contrast to pre-positioning supplies in specific locations, when organizations acquire such capabilities, they can be deployed worldwide. Second, these capabilities, especially those related to import processes, allow organizations to deliver supplies quickly from a centralized warehouse in cases of disaster. Third, investments in capabilities are generally durable and cost less than pre-positioning supplies in large quantities in many locations.

This section intends to evaluate the effects of investing in such disaster management capabilities through system dynamics modelling. We model the delivery process of a therapeutic food item during the immediate response phase of a disaster. By comparing a standard import scenario with one in which investments in capabilities have been made and one where supplies have been pre-positioned in the country, we demonstrate the improvement potential of these preparedness activities. We address the following research questions in detail: (3.1) How does supply pre-positioning and pre-disaster investment in capabilities reduce the delivery lead time of the relief supplies during the immediate disaster response in comparison to a standard import scenario? and (3.2) What is the potential of pre-disaster investment in capabilities, as compared to pre-positioning, in order to reduce the costs of the preparation phase? Finally, once our system dynamics model is developed, we will be able to answer the following methodological question: (3.3) How can system dynamics models be best used in humanitarian operations?

This section is structured as follows. First, we provide an outline of the relevant theory on disaster preparedness in humanitarian logistics. After giving an overview of the applied system dynamics methodology, we introduce our specific model and the various disaster relief scenarios. Subsequently, we present the results from our modelling and discuss the findings against the background of cost considerations as well as the previous literature in the field of humanitarian logistics. We conclude the section by highlighting the main findings as well as limitations, together with suggestions for future research.

This section is based on a paper which we presented at the 17th International Symposium on Inventories in Budapest, and that is currently under review at the International Journal of Production Economics (Kunz *et al.*).

6.1. Theoretical background

As mentioned in Section 2, humanitarian disasters generally require external (international) assistance in order to be resolved. This assistance may come from the local military or civil defence, but comes most often from relief organizations, which have the knowledge, capabilities and resources to help the populations in these crises. Due to on-going demographic growth, migration movements, and climatic shifts, there is strong evidence that the frequency of occurrence and the impacts of humanitarian disasters (such as flooding, droughts, and famines) will be increasing (Whybark, 2007); therefore, research in this field is increasingly needed.

From the four stages of humanitarian disaster management described by Van Wassenhove (2006) – *Mitigation*, *Preparedness*, *Response* and *Rehabilitation* – the first two take place before a disaster strikes, and aim at reducing the disaster's impact. They are hard to implement at reasonable costs, because the place, time, type and magnitude of the disaster is not known in advance (Duran *et al.*, 2011, Rawls and Turnquist, 2010). However, these phases play a crucial role in increasing the effectiveness of the response phase (Charles and Lauras, 2011, Gatignon *et al.*, 2010, Görmez *et al.*, 2011, Jahre and Heigh, 2008, Van Wassenhove, 2006).

Despite the strong potential of preparedness activities, several authors have found that this phase is often neglected by relief organizations because donors insist that their money be spent directly on helping victims (e.g., Beamon and Balcik, 2008, Duran *et al.*, 2011, Kovács and Spens, 2007, Maon *et al.*, 2009, Sandwell, 2011, Schulz and Blecken, 2010, Whiting and Ayala-Öström, 2009). Other authors (e.g., Besiou *et al.*, 2012, Jahre and Heigh, 2008, Pedraza-Martinez *et al.*, 2011) mention that donations are often earmarked to specific disaster response activities and programs, while more funds would be needed to cover the investments needed for warehousing the relief items and for keeping up permanent supply chain structures. Funding pre-disaster activities can be seen as a form of insurance policy against an uncertain future disaster, which most donors are not willing to pay for (Tatham and Pettit, 2010). However, there are donors that realize that a lack of investment in preparedness activities

leads to the chronic vulnerability of some communities and excessively high costs during the response phase (Majewski *et al.*, 2010).

By specifically searching for mentions of all disaster preparedness activities in the selection of 174 academic papers we compiled for our meta-analysis (see Section 4), two groups of preparedness activities were identified: physical and intangible.

Physical preparedness activities embrace all proactive investments in tangible resources in disaster-prone countries, namely, building up various kinds of inventories and infrastructure. In this respect, authors most often suggest pre-positioning relief supplies in warehouses (Table 6.1). Because this type of investments are specific to one location and can hardly be reallocated to disasters occurring in other countries, such a strategy generally leads to high investment costs that donors are often reluctant to finance. As an additional obstacle, Kovács and Spens (2009) found that the lack of pre-disaster exemptions from customs duties limits the ability of relief organizations to build up incountry inventories during the preparedness phase.

TABLE 6.1: TYPES OF PHYSICAL PREPAREDNESS ACTIVITIES

Investment in…	**Preparedness activities**
Inventory	- Pre-positioning of relief supplies in disaster-prone countries (Adivar and Mert, 2010, Altay and Green, 2006, Altay *et al.*, 2009, Balcik and Beamon, 2008, Duran *et al.*, 2011, Görmez *et al.*, 2011, Hale and Moberg, 2005, Jahre and Heigh, 2008, Jahre *et al.*, 2009, Kovács and Spens, 2009, Kovács and Spens, 2011b, Mete and Zabinsky, 2010, Oloruntoba and Gray, 2006, Pettit and Beresford, 2005, Rawls and Turnquist, 2010, Taskin and Lodree, 2011, Tomasini and Van Wassenhove, 2009b, Van Wassenhove, 2006)
Infrastructure	- Purchasing communication equipment and information technology needed for disaster response (Pettit and Beresford, 2005) - Building of tsunami-proof housing at protected locations (Perry, 2007) - Building of earthquake-resistant infrastructure (Natarajarathinam *et al.*, 2009) - Building of pre-disaster infrastructure, such as distribution centres, road networks, hospitals, emergency power plants (Kovács and Spens, 2009)

An interesting alternative to these physical preparedness activities are intangible preparedness activities. Van Wassenhove (2006) recommends investing in pre-disaster management capabilities, such as human resources, knowledge management, process management, resources and community. Such investment in capabilities allows relief organizations to be well prepared and have the needed abilities to respond swiftly to a disaster. These capabilities are

generally generic and multi-deployable, and can be shared among countries. Thus, high levels of responsiveness to a disaster can be ensured with significantly less initial investment. Table 6.2 presents the intangible preparedness activities that are discussed in the academic literature, categorized into Van Wassenhove's (2006) framework.

TABLE 6.2: TYPES OF INTANGIBLE PREPAREDNESS ACTIVITIES (BASED ON VAN WASSENHOVE, 2006)

Investment in…	**Preparedness activities**
Human resources	- Training of staff (Altay and Green, 2006, Perry, 2007, Pettit and Beresford, 2005, Van Wassenhove, 2006) - Hiring disaster mitigation and preparedness specialists (Benson *et al.*, 2001) - Hiring and training local staff to respond to disasters (Van Wassenhove, 2006)
Knowledge management	- Learning from previous disaster response experiences and developing best practices (Charles and Lauras, 2011, Van Wassenhove, 2006) and "preparedness templates" for different types of disasters (Day *et al.*, 2012) - Early warning systems (Oloruntoba, 2010, Van Wassenhove, 2006) - Decision-making models and tools (Adivar and Mert, 2010, Balcik and Beamon, 2008, Banomyong and Sopadang, 2010, Day *et al.*, 2009, Görmez *et al.*, 2011, Mete and Zabinsky, 2010, Nolz *et al.*, 2010, Özdamar, 2011, Rawls and Turnquist, 2010, Taskin and Lodree, 2010, Tovia, 2007, Ukkusuri and Yushimito, 2008) - Disaster damage (e.g., earthquake) scenarios (Barbarosoglu and Arda, 2004)
Process management	- Pre-negotiating agreements with suppliers and logistics providers (Altay *et al.*, 2009, Duran *et al.*, 2011, Kovács and Spens, 2007, Van Wassenhove, 2006) - Preparation of organizational structures, response plans within relief organizations and arrangements with other organizations (Altay and Green, 2006, Görmez *et al.*, 2011, Jahre *et al.*, 2009, Oloruntoba, 2010, Pettit and Beresford, 2005)
Resources	- Preparation of financial resources for early response (Van Wassenhove, 2006) - Postponement and pooling of resources (Jahre and Heigh, 2008, Kovács and Tatham, 2009b, Tomasini and Van Wassenhove, 2009b)
Community	- Educating vulnerable communities to recognize specific pre-disaster events and to respond accurately (Banomyong *et al.*, 2009, Benson *et al.*, 2001, Kovács and Spens, 2009, Oloruntoba, 2010, Perry, 2007, Van Wassenhove, 2006) - Assessing the economic and physical vulnerabilities of populations in disaster planning (Perry, 2007) - Cooperating with local governments, military, humanitarian organizations and businesses in order to establish framework agreements or permanent networks of actors (Jahre *et al.*, 2009, Van Wassenhove, 2006) - Pre-negotiating customs agreements with local governments (Kovács and Tatham, 2009b) - Disaster planning by local governments and NGOs, in collaboration with local communities (Adivar and Mert, 2010, Perry, 2007)

6.2. Methodology

In order to quantify the lead time reduction potential of pre-disaster investments in humanitarian logistics, we used system dynamics modelling based on empirical data. Specifically, we modelled the delivery process of a therapeutic food item during the immediate response phase of a disaster. Our model is fed by primary data collected from the case study among four relief organizations presented in Section 5, which allowed us to first develop a "mental database" of the problem (Forrester, 1994), and then to build a model based on these practitioners' experiences. We also used publicly available secondary data from producers' and relief organizations' websites. In combining these primary and secondary data sources, we kept our model as close to reality as possible. In particular, we analysed the lead time reduction potential of investing in disaster management capabilities as described by Van Wassenhove (2006). Through our model, we also analysed the impact of pre-positioning supplies in a disaster-prone country during the preparation phase of a disaster on delivery lead time.

We chose to use this methodology for different reasons. First, system dynamics models allow the consideration of interacting feedback loops (Reiner and Natter, 2007), of which we find several examples in our model (see Appendix D and E). Dynamic problems containing feedback loops cannot be solved through standard optimization methods, which are suitable for static systems that are free of feedback loops (Sterman, 1991). This is often not the case in humanitarian operations (Besiou *et al.*, 2011), nor in our model. Other methods, such as stationary queuing models also fail to grasp the full complexity of our dynamic system. Second, our model includes time delays, as the demand of beneficiaries is satisfied only for a given period, before returning in the pool of unsatisfied demand. The effects of such delays must be studied through dynamic models, allowing consideration of dependencies over multiple periods (Reiner and Natter, 2007). Functions in our model are nonlinear (e.g., S-shaped curve representing the customs clearance process capacity, see Fig. 6.2), which can be modeled particularly well through system dynamics (Sterman, 2000). Finally, multi-period inventory systems are dynamic by nature, and can therefore be well studied through system dynamics (Forrester, 1961). An additional benefit of using quantitative system dynamics models is that they allow to explore and test alternative scenarios in a risk-free environment, allowing their impact on the performance of the system to be tested (Santos *et al.*, 2002). Another reason for using system dynamics for our model is that this modeling tool is highly appreciated and well understood by managers because it enriches brainstorming, and has a lower reliance on hard data than other methods (Jahangirian *et al.*, 2010). Based on these reasons, and

because the alternative methodologies described above were not well adapted, we decided to use system dynamics methodology for this study. We will now give some examples of applications of this method to operations management research.

Forrester (1961) started to apply dynamic models to managerial issues. A well-known example is the beer game, which shows the consequences of ill-defined supply chain processes (Sterman, 1989). According to several authors, this method is also well adapted to study the field of disaster management. Altay and Green (2006) found that the social and political nature of disaster operations management makes this field suitable for research approaches, such as system dynamics, which can integrate soft factors into the operations analysis. System dynamics modelling is well adapted to gain insight into systems over time that have multiple actors, high levels of uncertainty, and complexity (Besiou *et al.*, 2011). This appropriateness is reflected by three studies that applied system dynamics to humanitarian operations in recent years. Gonçalves (2008) used this methodology to model the development of organizational capabilities and the efficiency of the relief efforts of humanitarian organizations. In a follow-up study, the author analysed the trade-off between providing relief assistance and building capacity in relief organizations (Gonçalves, 2011). Besiou *et al.* (2011) used this methodology to assess different scenarios of vehicle fleet management in humanitarian operations. They used this tool to determine the long-term costs of different scenarios and to identify the scenario that best satisfied the needs of a particular organization over several years. The authors recognized the lack of real-world data for their models as a limitation of their research. This is where our study ties in, by explicitly integrating empirical data gathered through previous case study research into the system dynamics modelling approach.

6.3. Model

Given the difficulties faced by relief organizations in getting funding for pre-disaster activities, this section aims to quantify and compare the effects of three scenarios: no preparedness activity, investment in physical preparedness activities, and investment in intangible preparedness activities. In particular, we model the delivery process of a therapeutic food item, Plumpy'nut ready-to-use therapeutic food sachets (Nutriset, 2012), during the immediate response phase of a disaster. We ran the system dynamics model over 180 periods (days), with a time interval (Δt) of one day. The model was tested for up to 400 days, in order to make sure that no unexpected phenomenon arises in the long term.

In order to reduce complexity and isolate the phenomenon under study, we developed a simplified model of the importation process of Plumpy'nut sachets (Fig. 6.1). The standard input parameters of the basic model are listed in Table 6.3.

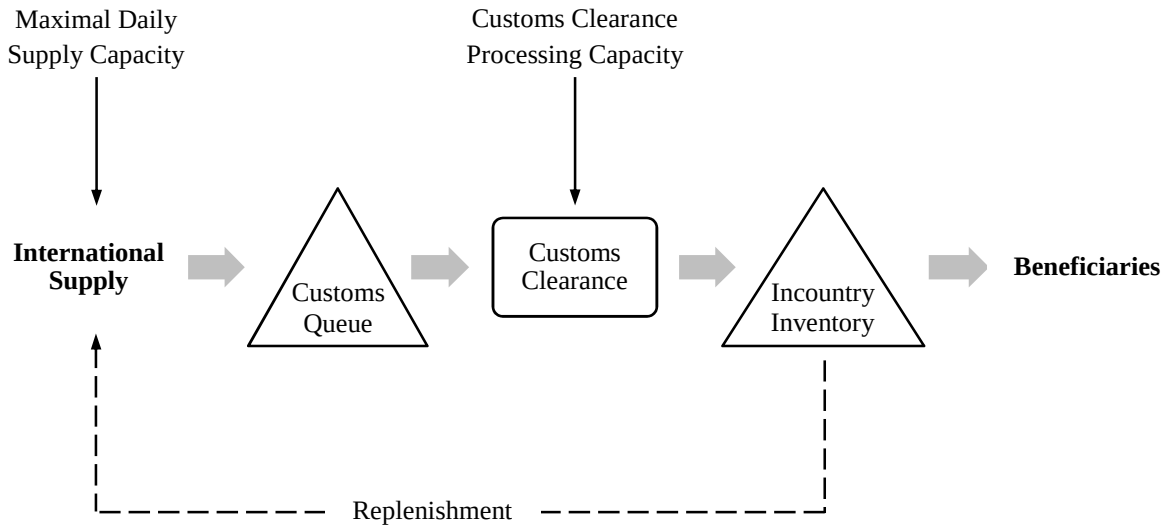

Figure 6.1: Simplified model of importation process of relief supplies

TABLE 6.3: STANDARD INPUT PARAMETERS

Parameters		**Value**
Pre-positioned Inventory		0
Customs Clearance Processing Capacity	Maximal Fractional Capacity Increase	0.3
	Initial Capacity	200 kits/day
	Maximal Capacity	100,000 kits/day
Time interval (Δt)		1 day
Initial Demand		500,000 kits
Lifetime of Demand Satisfaction		10 days
Maximal Daily Supply Capacity		38,820 kits/day (100 tons)
Average Duration of Treatment		8 weeks (56 days, 5.6 deliveries)
Fraction Returning Demand		0.82
Safety Inventory (I_s)		100,000 kits

Based on the information found on Nutriset's website, the producer of Plumpy'nut (Nutriset, 2012), we were able to quantify the number of sachets needed to cover the needs of the 500,000 beneficiaries (children) of our disaster response model. The unit selected in our model is a kit of 28 sachets, which covers the demands of one child during ten days

(parameter *Lifetime of Demand Satisfaction*). After this period, the beneficiary flows again into the pool of unsatisfied demand. At the end of the average length of eight weeks of treatment, the beneficiary leaves the demand pool, because its demand is definitively satisfied. This is modelled through the constant *Fraction Returning Demand* in equation 6.1, which represents the proportion of the demand flowing again into the unsatisfied demand pool after each period. As only a fraction of the temporarily satisfied demand flows again into the pool of unsatisfied demand, the unsatisfied total demand decreases exponentially over time. We consider that a residual demand will always exist, and therefore we did not limit the returning demand to the eight weeks of treatment. Due to the ten days of *Lifetime of Demand Satisfaction,* there is no returning demand during the first ten days following the disaster (see equation 6.1).

$$Returning\ Demand_{\ t} = \begin{cases} 0, & for\ t \leq 10 \\ Fraction\ Returning\ Demand \cdot \frac{Temporarily\ Satisfied\ Demand_{\ t}}{Lifetime\ of\ Demand\ Satisfaction}, & for\ t > 10 \end{cases} \quad (6.1)$$

Temporarily Satisfied Demand (see equation 6.2) represents the pool of beneficiaries that are currently satisfied (i.e., received a kit during the last ten days), but who may need aid again once their kit is consumed. *Temporarily Satisfied Demand* decreases over time because the unsatisfied demand decreases, leading to fewer and fewer deliveries to beneficiaries. Also, as described in the last part of equation 6.2, after each period a fraction of the *Temporarily Satisfied Demand* leaves this pool.

$$Temporarily\ Satisfied\ Demand_{\ t} = Temporarily\ Satisfied\ Demand_{\ t-1} + Deliveries\ to\ Beneficiaries_{\ t-1} - \frac{Temporarily\ Satisfied\ Demand_{\ t-1}}{Lifetime\ of\ Demand\ Satisfaction} \quad (6.2)$$

The pool of unsatisfied demand is modelled as shown in equation 6.3.

$$Unsatisfied\ Demand_{\ t} = Unsatisfied\ Demand_{\ t-1} + Returning\ Demand_{t-1} - Deliveries\ to\ Beneficiaries_{t-1} \quad (6.3)$$

In our simplified model, relief items arrive as *International Supply* by airplane. Orders are placed on a daily basis, following a periodic review of the base stock (t, S - Policy) explained in equations 6.8 to 6.13. The maximal daily supply capacity is limited to 100 tons per day (i.e., 38,820 kits). This is the payload of the Antonov AN-124, a large cargo plane that was used in the aftermath of the Haiti earthquake to deliver High Energy Biscuits (WFP, 2004). After arriving at the airport, the supplies go through the *Customs Queue*, where they wait until they go through the clearance procedure.

In our basis model (no preparedness), this processing capacity is extremely low just after the disaster (200 kits/day), due to unprepared staff and a lack of clearly established procedures on the part of both the government and the relief organization. This capacity then increases progressively until it reaches the maximal processing capacity of 100,000 kits per day, following an S-shaped curve often used in non-linear population growth models. We modelled this growth with a logistic growth function (Sterman, 2000), which is characterized by a decreasing *Fractional Capacity Increase* levelling out at zero while the processing capacity increases until it reaches *Maximal Capacity*, as shown in equation 6.4.

$$Fractional\ Capacity\ Increase_t = Maximal\ Fractional\ Capacity\ Increase \cdot \left(1 - \frac{Processing\ Capacity_{t-1}}{Maximal\ Capacity}\right) \quad (6.4)$$

The *Processing Capacity* is calculated as shown in equation 6.5, resulting in the S-shaped curve.

$$Processing\ Capacity_t = Processing\ Capacity_{t-1} \cdot (1 + Fractional\ Capacity\ Increase_t) \quad (6.5)$$

From customs clearance, the items are sent to the *Incountry Inventory* as described below in equation 6.6. This equation shows that in each period, all items in the *Customs Queue* are cleared and flow to the *Incountry Inventory*, however not exceeding the customs *Processing Capacity* in this period.

$$Outflow\ Customs\ to\ Incountry\ Inventory_t = MIN(Customs_t, Processing\ Capacity_t) \quad (6.6)$$

From the *Incountry Inventory*, items are dispatched directly to the beneficiaries, following the decision rule in equation 6.7. According to this rule, all of the items in inventory are delivered directly to the beneficiaries, as long as the unsatisfied demand is higher than the inventory level. In our purely theoretical model, neither transport nor repackaging time has been included. This simplification was made in order to isolate the phenomenon under study, the effect of preparedness.

$$Deliveries\ to\ beneficiaries_t = MIN(Incountry\ Inventory_t, Unsatisfied\ Demand_t) \quad (6.7)$$

The international supply flowing into our model is defined by a replenishment strategy depending on the *Unsatisfied Demand* and the *Pipeline Inventory*. The *Order Quantity* is defined as shown in equation 6.8, and cannot exceed the maximal daily supply capacity of 38,820 kits (i.e., one cargo plane). If the *Unsatisfied Demand* is lower than the *Pipeline Inventory*, a base stock replenishment is performed as presented in equation 6.10.

$$Order\ Qtity_t = \begin{cases} Unsatisfied\ Demand_t - Pipeline\ Inventory_t + DDLT_t\ , & Unsatisfied\ Demand_t > Pipeline\ Inventory_t \\ Base\ Stock\ Replenishment_t\ , & Unsatisfied\ Demand_t \leq Pipeline\ Inventory_t \end{cases} \quad (6.8)$$

$$Pipeline\ Inventory_t = Customs\ Queue_t + Incountry\ Inventory_t \quad (6.9)$$

If the *Unsatisfied Demand* is lower than the *Pipeline Inventory*, a base stock replenishment is done as presented in equation 6.10.

$$Base\ Stock\ Replenishment_t = \begin{cases} DDLT_t - Pipeline\ Inventory_t + I_s\ , & DDLT_t \geq Pipeline\ Inventory_t \\ I_s - Pipeline\ Inventory_t\ , & DDLT_t < Pipeline\ Inventory_t < I_s \\ 0\ , & Pipeline\ Inventory_t \geq DDLT_t \geq I_s \end{cases} \quad (6.10)$$

If the *Demand During Lead Time* (*DDLT*, equation 6.11) is higher than the *Pipeline Inventory* (equation 6.9), a base stock replenishment order equal to the difference between the *DDLT* and the *Pipeline Inventory*, plus a *Safety Inventory (I_s)* quantity is placed. If the *Pipeline Inventory* is higher than *DDLT* but lower than the *Safety Inventory (I_s)*, the difference between *Safety Inventory (I_s)* and *Pipeline Inventory* is ordered. If the *Pipeline Inventory* is higher than the *DDLT* and the *Safety Inventory (I_s)*, no order is placed.

DDLT is calculated with a ten day moving average of past demand and the customs clearance flow time. Because of the ten days chosen for the moving average, the calculation of *DDLT* has been adapted to the first ten days. During this time, it is calculated based on the average demand since Day 0 (see first line in equation 6.11). The *Flow Time Customs Clearance* is calculated by using the function "QUEUE AGE AVERAGE" of our simulation software (Vensim). At each period, this function returns the average age of the items which are in the *Customs Queue* (Vensim, 2012). We used this function because it provided realistic results during the first days of the simulation, when throughput is extremely low and the customs queue very long.

$$DDLT_t = \begin{cases} \frac{Cumulative\ Unsatisfied\ Demand_t}{t}\ , & t \leq 10 \\ Flow\ Time\ Customs\ Clearance_t \cdot Moving\ Average\ of\ Unsatisfied\ Demand_t\ , & t > 10 \end{cases} \quad (6.11)$$

$$Cumulative\ Unsatisfied\ Demand_t = \sum_{i=1}^{t} Unsatisfied\ Demand_i \quad (6.12)$$

$$Moving\ Average\ of\ Unsatisfied\ Demand_t = \frac{\sum_{i=t-10}^{t} Unsatisfied\ Demand_i}{10}, \quad for\ t > 10 \quad (6.13)$$

6.4. Scenarios

By modelling three different scenarios, we compare the effects of preparedness in terms of delivery lead time. Table 6.3 presents the input parameters of the basic model, and Table 6.4 gives the variable scenario parameters.

6.4.1. Scenario A: No preparedness

In Scenario A, no preparedness activity was carried out before the disaster. This scenario corresponds to the basic model presented in the previous section, and will allow us to demonstrate the effects of the other two scenarios. The customs clearance daily processing capacity increases slowly, following the S-shaped curve shown in Fig. 6.2 (blue line).

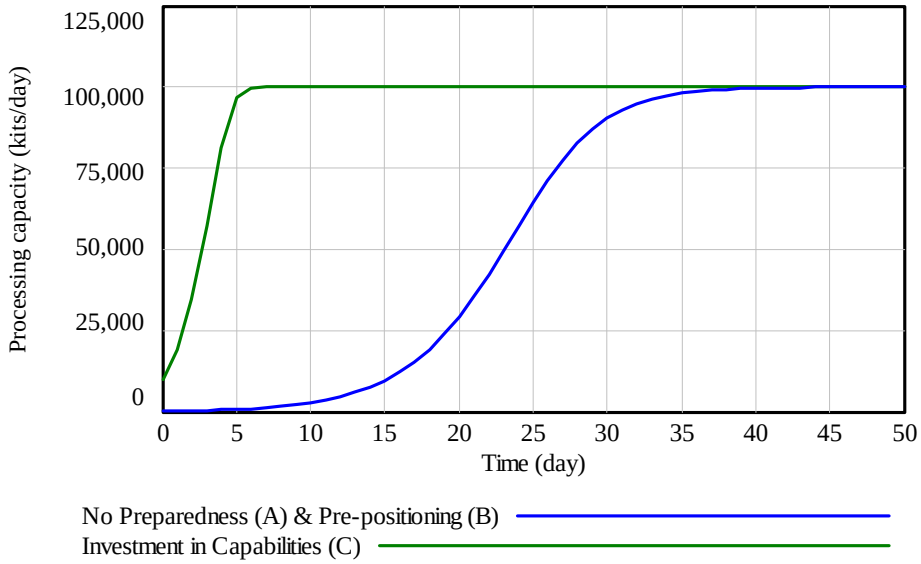

Figure 6.2: Daily processing capacity of customs clearance

6.4.2. Scenario B: Pre-positioning of inventory

In Scenario B, we model the effect of pre-positioning physical inventory in a central warehouse in the country prior to the disaster. This is achieved by setting an initial value of 900,000 Plumpy'nut kits to the *Incountry Inventory* variable. This quantity was chosen in order to achieve a 100% service level during the entire time following the disaster. In this scenario, we consider that the demand of all of the beneficiaries is satisfied immediately after the disaster through the pre-positioned inventory. However, we do not model the returning demand as a peak occurring exactly after the ten days of *Lifetime of Demand Satisfaction*, but rather as a continuous returning demand starting from Day 10. This allows us to keep the

model closer to reality. Indeed, the entire population of beneficiaries will not arrive at the point of distribution after ten days exactly. Returning demand is therefore modelled as presented in equation 6.1.

6.4.3. Scenario C: Investment in disaster management capabilities

In Scenario C, investments in capabilities were made at the level of the customs clearance procedure. In this scenario, we consider that the relief organization applies intangible preparedness activities in the focal country, such as those presented in Table 6.2. First, the relief organization's staff is trained to handle the importation and clearance procedure in the correct way. They analyse existing customs documentation and the procedures of the focal country in order to make sure that the organization is able to deliver all of the needed documents quickly in case a disaster happens. Second, regarding knowledge management, the organization collects information about past disasters in this country, creates a risk profile of the country, and develops possible disaster scenarios. Third, regarding process management, the organization develops a set of operations procedures for customs clearance in this country. If possible, the organization pre-negotiates agreements with clearing agents in the country that may be of help for handling the importation process in case of disaster. International and local organizations can be contacted in order to prepare possible cooperation agreements. Fourth, resources are prepared, mainly in the form of cash reserves, allowing the organization to respond immediately in the case of a disaster. The organization can identify sources of well-qualified local staff that can be hired immediately in case a disaster happens. The type and amount of transport equipment needed for this country is assessed, and plans are made to mobilize it. Fifth, the local community is involved in the preparation effort. A meeting with relevant officials in the country allows the relief organization to build up a relationship with the key people that can help it in the case of disaster. A memorandum of understanding is negotiated with the local government. Customs agreements are negotiated, and procedures are harmonized with the requirements of the country. Common disaster response plans are developed with the relevant institutions in the country. These investments in capabilities lead to a customs clearance processing capacity that increases much faster than in the other scenarios. We modelled this faster increase by changing the parameters of the S-shaped processing capacity curve, as presented in Table 6.4. The resulting processing capacity curve can be seen in Fig. 6.2 (green line).

TABLE 6.4: THE SCENARIOS' PARAMETERS

		Scenario A No Preparedness	**Scenario B** Pre-positioning of Inventory	**Scenario C** Investment in Capabilities
Pre-positioned Inventory		0	900,000 kits	0
Customs Clearance Processing Capacity	Maximal Fractional Capacity Increase	0.3	0.3	1
	Initial Capacity	200 kits/day	200 kits/day	10,000 kits/day
	Maximal Capacity		100,000 kits/day	

6.4.4. Validation of our model

The validation of a systems dynamics model is an important step which ensures the validity of the findings (Barlas, 1996, Reiner *et al.*, 2009). Barlas (1996) makes a difference between philosophical and formal aspects of model validation (Reiner *et al.*, 2009). Before formally validating the behaviour and the results of the model, the validity of the internal structure of the model has to be tested (Barlas, 1996, Sterman, 2000). In our case, this philosophical validation was ensured by the integration of established knowledge in our model (Miser and Quade, 1988). Indeed, we based our model on concepts discovered during our case study research (e.g., pre-clearance processes when previous relationships are established with the customs in a country, hiring of staff dedicated to handle the customs clearance process, etc.). We also integrated empirical data from real-life disasters in our model (e.g., maximal daily supply capacity of an aircraft, number of items needed per beneficiary, etc.). On a more theoretical level, we integrated structural components that have been successfully used by previous studies (Miser and Quade, 1988, Reiner *et al.*, 2009), for example when we used Sterman's (2000) logistic function to model our S-shaped curve of the customs clearance processing capacity.

The second step of the validation is the test of the behavioural accuracy of the model, which was done by comparing the fit of the outcomes of the model with empirical historical data (Reiner *et al.*, 2009). However, given the methodology chosen in our previous study (case study research) we did not have access to such historical data, and we could therefore not perform the usually recommended statistical tests such as the mean absolute percent error (MAPE) or Theil's inequality (Lin *et al.*, 2008, Oliva and Sterman, 2001, Reiner *et al.*, 2009). Therefore, we first compared the general outcomes of the simulation (shape of graphs) with the "mental database" (Forrester, 1994) we had developed through our case study research. Second, we compared specific output figures (e.g., lead-time, customs processing capacity)

with the empirical results of our case study research. For example, several statements from practitioners we interviewed mentioned customs clearance lead times of up to 4 weeks when no previous relationships were established with customs, which corresponds to the lead time found by our model (around 30 days after the disaster, see Figure 6.4). Finally, we performed some extreme conditions tests similarly to Besiou *et al.* (2011), for example by extending the simulation period (up to 400 days) and checking if the model behaved correctly. The robustness of our results was also analysed by checking the variation of the outputs when varying some input parameters, such as the level of prepositioned incountry inventory.

6.4.5. Limitations of our model and scenarios

The aim of our model is to compare preparedness scenarios with each other by varying only those parameters relevant to the preparation activities. In order to isolate the problem under study, we neglect various parameters that are relevant to the overall process of providing humanitarian relief in reality. For example, we did not include any variability in our model, nor did we include parameters such as transport time.

Another limitation of our model is its narrow focus on a single disaster, single country and single organization. Interactions, interdependencies and repercussions between the organizations and the multiple countries affected by the same disaster are common features of real disaster situations that increase the complexity of humanitarian relief management; such aspects are, however, neglected in the extant model, which deliberately focuses on the effects of preparedness for supply delivery lead time.

Furthermore, we focus on three extreme case scenarios, while the optimal solution is assumed to lie somewhere between Scenario B (Pre-positioning) and Scenario C (Investment in Capabilities). Determining this optimal solution is beyond the scope of the current study. Nonetheless, such a research aim would warrant addressing in a follow-up study.

Finally, the validation of our model could be improved by performing statistical tests between our results and historical empirical data.

6.5. Results

By comparing the results of the simulation for the three scenarios presented above, the efficiency of the different preparedness strategies can be analysed.

Fig. 6.3 shows that without any preparedness activity (Scenario A), there is a strong build-up of inventory in the customs clearance queue, which can be avoided by pre-positioning supplies in the country (Scenario B). The build-up can also be avoided by investing in the capabilities of the customs clearance process (Scenario C), which leads to a faster increase in the customs clearance processing capacity. As can be seen in Fig. 6.2, full processing capacity is achieved on the 7th day following the disaster, compared to the 40th day without investments in capabilities.

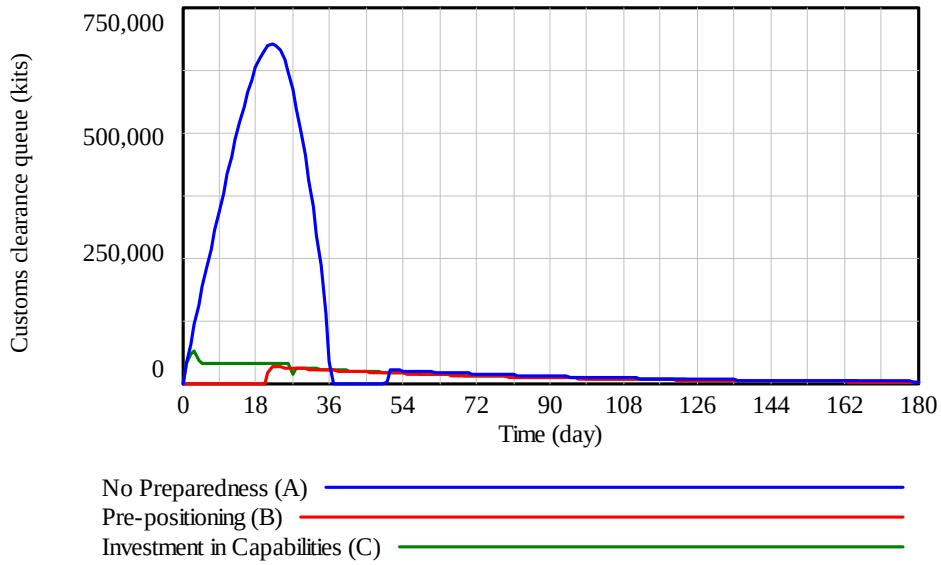

Figure 6.3: Customs clearance queue

The total unsatisfied demand can be seen in Fig. 6.4. Without preparedness, the demand is satisfied slowly and only reduces significantly from the 20th day following the disaster. With the pre-positioning of supplies, the full demand is satisfied immediately, and returning demand arises after 10 days. With the investment in capabilities, the demand is satisfied quickly, as soon as the customs clearance process reaches its full capacity. From Fig. 6.4, it can be seen that in Scenario C, the needs of the first 300,000 beneficiaries are met after 9 days, while it takes 27 days until the same level is reached without preparedness (Scenario A). A potential lead time reduction of 18 days for serving the first 300,000 beneficiaries, or 67% (a reduction from 27 days to 9 days), can therefore be realized when investing in capabilities.

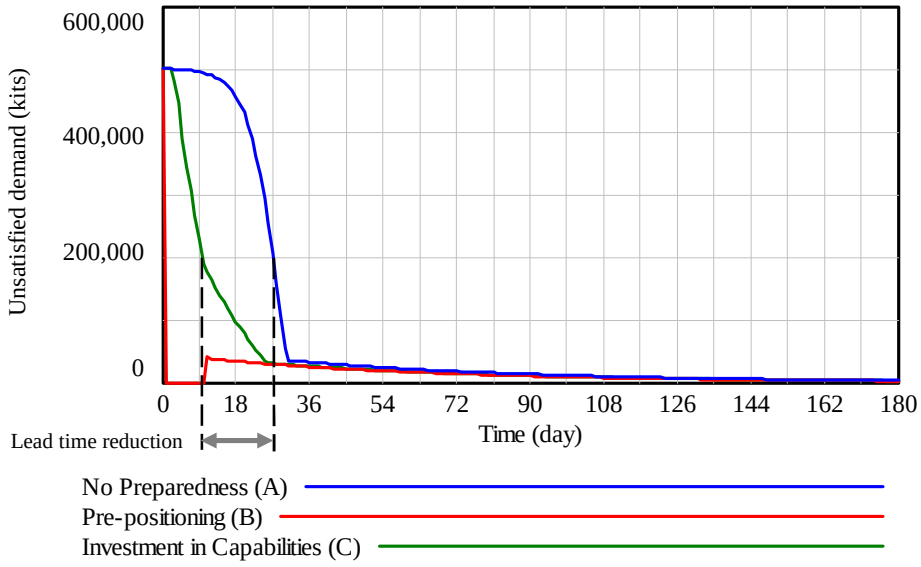

Figure 6.4: Unsatisfied demand

Fig. 6.5 presents the service level of the deliveries of Plumpy'nut kits. While the pre-positioned inventory level in Scenario B was set with the aim of reaching a 100% service level for the whole time following the disaster, in the other two scenarios it begins at zero. With no preparedness (Scenario A), the service level increases slowly and reaches 100% on the 30th day after the disaster. With the investment in capabilities (Scenario C), the service level increases faster and reaches 100% on the 25th day after the disaster. While this five days' difference between the two scenarios may seem insignificant (-16%), a closer look at Fig. 6.5 shows that the two scenarios result in different results during the first days of the simulation. Indeed, on the fourth day after the disaster, Scenario C already shows a 13% service level, while Scenario A remains at a 0.08% service level.

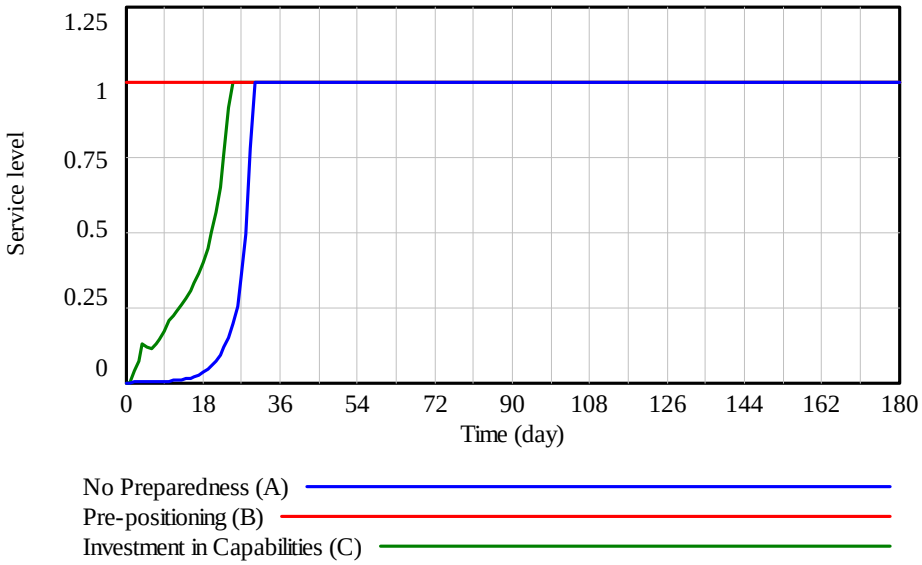

Figure 6.5: Service level

6.6. Discussion

The results of modelling the three scenarios warrant closer consideration and discussion. Scenario A, with no pre-disaster preparedness activities, leads to disastrous results, because the highest proportion of the relief items is delivered only weeks after the disaster happened. This was confirmed by the head of logistics services of a major relief organization, who explained that in countries where no pre-clearance process exists, it takes 3-4 weeks between the first import authorization request and the actual arrival of goods in the country (see Section 5).

The results of this simulation model also confirm the positive effect of the physical pre-positioning of inventory in warehouses in disaster-prone countries, which has been supported by many authors so far (see Table 6.1). By pre-positioning the right number of relief supplies in a country prior to a disaster, a high service level can be achieved almost immediately after the disaster hits. The pre-positioning of supplies, therefore, produces the best results for the beneficiaries. This scenario is also interesting in terms of transportation costs, as pre-positioned items can be economically delivered by ship or truck. However, this scenario involves high holding costs for the relief organizations. In our model, the relief organization pre-positions an incountry inventory of 900,000 kits, which corresponds to an investment cost of 6.25 million €, based on the official cost of Plumpy'nut at 2.7 €/kg (Pillon, 2012). An average holding cost (financial + storage) of 25% leads to a yearly cost of 1.56 million €.

A sensitivity analysis was performed by varying the incountry inventory level. We reduced this level until we achieved the same average service level (over 180 days) as in Scenario C, 90%. This service level was reached with an inventory level of 498,000 kits, which corresponds to an investment cost of 3.5 million € and a yearly holding cost of 875,000 € to keep these supplies in stock. Based on this result, we found that even by reducing the pre-positioned inventory, and thus the service level, the investment and holding cost remain high. In order to avoid customs clearance, supplies have to be pre-positioned in every single country prone to disasters. The resulting total holding cost therefore increases proportionally with the number of countries covered by the organization. Transportation costs for the pre-positioned inventory also occur in each of these countries. One additional problem related to the pre-positioning of inventory refers to product expiry (Whybark, 2007). The Plumpy'nut sachets, for example, can be stored for a period of 24 months (Nutriset, 2012). Before reaching its expiration date, the stock has to be renewed and unused items have to be sold on the local market or re-exported to another country where they are needed. These high costs and risks explain why international donors are unwilling to pay for such investments as pre-positioned inventories. This reluctance was confirmed by Tatham and Pettit (2010), who found that most donors are not ready to pay for an expense that can be considered as an "insurance policy" against future disasters.

Scenario C, in which the relief organization invests in capabilities instead of physical assets, represents an interesting alternative to Scenarios A and B. Indeed, in Scenario C the demand is satisfied much more quickly than in Scenario A (lead time reduction of 67%), and the costs are far lower than in Scenario B, even at a similar service level. While some possible ways of investing in capabilities were presented in Table 6.2, it is hard to quantify the exact costs of these strategies, as they depend largely on the type of country, the organization's previous presence in a country, its current level of preparation, and the level of resilience of the local communities. Such investments in capabilities mainly involve preparatory work at the head-quarters, which needs to be done only once. The procedures that are set up have to be updated regularly in order to make sure they are up-to-date, but this follow-up activity involves a relatively low workload. Also, most of this preparatory work is applicable to several countries, or transferable between single countries. For example, once importation operating procedures are developed for one country, they can be adapted for other countries with minor effort. Similarly, the cash reserves needed for immediate action in the case of disaster is not country-specific, and therefore has to be set up only once.

The downside of investing in capabilities as compared to the pre-positioning scenario is that the supplies are stored in one central or several regional warehouses, from where they are sent by air to the country hit by the disaster. The emergency nature of these transports involves higher international transportation costs than for the pre-positioned inventories, which can be shipped by maritime transport. Nonetheless, considering all of the countries where preparedness activities are carried out, this effect is reduced by the fact that the higher airplane transportation costs only occur for the country where the disaster strikes, instead of all of the countries where inventory has been pre-positioned. While we considered a single organization approach in our model, reality is more complex, as several relief organizations work in the same country and pursue similar objectives. If left uncoordinated, pre-disaster preparatory activities conducted by several organizations in the same country may lead to confusion among the country's officials, as well as to considerable duplication of activities. Therefore, we believe that a core condition for investment in capabilities to be successful is that a coordination body oversees the preparedness activities undertaken in a country. This coordination, and ideally even some elements of the intangible preparedness activities, could be handled by a United Nations (UN) organization, such as the Logistics Cluster. This inter-agency coordinating body, led by the UN World Food Programme (WFP), brings together relief organizations, UN agencies, and governments, and follows the aim of coordinating activities and sharing information among implementing partners in disaster-affected countries (Logistics Cluster, 2012).

6.7. Summary

This section compares three disaster response scenarios by means of a system dynamic modelling approach. We find that the pre-positioning of inventory leads to the best results in terms of demand satisfaction, however, at high investment and holding costs, which can barely be financed by the currently existing funding and fund-raising mechanisms. In addition, due to product expiry, pre-positioned inventories of relief items such as Plumpy'nut must have a two-year inventory turnover, which is hard to achieve when there is no disaster in the country or in neighbouring countries. As a valuable alternative to such pre-positioning of inventory, we find that investments in capabilities achieve remarkable results at much lower costs. Compared to the scenario without preparedness, we find that a lead time reduction of 18 days (-67%) can be achieved, for example, by preparing and harmonizing importation processes, training staff and negotiating customs agreements with the government prior to the disaster.

While it is hard to quantify the exact costs of such strategies, the cost reduction potential is obvious, because the intangible preparedness work only has to be done once, requiring limited follow-up work for keeping the procedures up-to-date. Also, the capabilities built up for one country can be reused and adapted for other countries prone to disasters, thus reducing the cost per country. Based on our results, we state that investments in capabilities and investments in inventory constitute substitutes to a certain extent, since the build-up of capabilities allows a reduction of inventory, without affecting the service level.

On the methodological side, we confirm that system dynamics is a useful tool for comparing scenarios in the context of humanitarian operations. Faced with the high variability and complex processes of humanitarian operations, we isolated the core research problem from its context, which allowed us to compare the effects of the scenarios in relative terms.

Based on our findings, we recommend that donors finance more preparedness activities in countries prone to disasters. In addition, relief organizations may want to focus on different promotion strategies, for example, highlighting their on-going contributions to making local communities more resilient to disasters, rather than putting actual disaster response campaigns in the spotlight of their marketing campaigns. While the pre-positioning of inventory shows the best results for the beneficiaries, it involves high costs and risks for the relief organizations. This might lead to donors' unwillingness to pay for such activities. When faced with this problem, we recommend that relief organizations invest in capabilities such as training staff, negotiating customs agreements with local governments before a disaster strikes, developing and harmonizing importation procedures, and so on. Such intangible preparedness activities have a strong potential to reduce lead time in cases of disaster when compared to settings with no preparedness, while involving limited costs. We encourage one of the major UN organizations (e.g., the Logistics Cluster of the WFP) to coordinate the intangible preparedness activities undertaken by relief organizations in countries prone to disasters. Optimally, such an organization could even engage in performing some of the intangible preparedness activities, thus reaching efficiency gains by pooling these activities. Finally, we encourage local governments to support and cooperate with relief organizations in such preparedness activities.

A limitation of our research in this section is that we do not calculate the total costs involved in each scenario in detail. This limitation could be addressed by further research that analyses the costs of investing in capabilities in more detail, so as to provide robust estimates of the

cost reduction potential of this scenario in comparison to the supply pre-positioning scenario. Similarly, transport cost differences according to different transport modes (ship, airplane) that are linked to the strategies of pre-positioning and investment in capabilities could be integrated into future modelling research. Follow-up work may also consider variability, mainly on the demand side, and additional parameters, such as incountry transport time. Finally, further research could complement the extreme case scenarios presented in this section with a middle case scenario consisting of the optimal mix of pre-positioning and investment in capabilities. Such an optimal scenario would aim at balancing the trade-offs between service level, costs and response speed.

7. Conclusion

This PhD thesis addresses an important topic, which has been mentioned by several authors, and answers to a new trend evoked by several relief organizations, namely the increasing impact of import barriers on humanitarian logistics. Until now, there has been a lack of empirical research and field studies in humanitarian logistics. Also, existing case study research tends to concentrate on single case studies, specific phases and types of disasters (Kovács and Spens, 2011b). Our selection of cases, in combination with quantitative empirical modelling oriented research, overcomes these limitations.

As expressed by the title of this thesis, "Performance of Humanitarian Logistics affected by Situational Factors", our aim is to analyse how performance of humanitarian logistics is affected by external situational factors of disasters. We have first mapped the current literature on humanitarian logistics in order to identify the situational factors studied so far. We then developed a research framework defining performance of humanitarian logistics as the extent to which relief organizations are able to reach a strategic fit between their enablers and the beneficiaries' needs. This fit is influenced by the internal factors (enablers, impacted by donations), as well as external situational factors. In the second part of the thesis, we tried to understand how one particular situational factor, local government, affects humanitarian logistics. We further narrowed our focus on one governmental factor, namely import barriers imposed by governments on relief organizations when importing relief supplies. In this part of the research, we found that this impact varies, depending on the phase of the disaster, the age of the program and the fragility of the government. In the last part of the thesis, we used an empirical quantitative modelling technique to test some alternatives to reduce the impact of these barriers on performance. We found that this impact can be mitigated through different preparedness solutions. Relief supplies can be prepositioned in disaster prone countries, or disaster management capabilities can be developed before the disasters, especially in the importation process. The second option offers a strong lead time reduction potential while keeping investment costs low.

Our findings help academics and practitioners learn how humanitarian organizations can cope with import barriers in the best way, under consideration of their mixed effects in different time horizons. Our findings were used to develop a set of recommendations aimed at logistic directors and operation directors of relief organizations. These recommendations help them in different decision areas, such as the number and type of staff they allocate to a particular

operation in the different phases of disasters, the design of operational processes or the level of development of capabilities. Our results also help national governments to reshape the way they control humanitarian organizations in order to increase the overall effectiveness and efficiency of humanitarian operations conducted on their territory. Our findings could, for example, suggest governments to develop a policy allowing a temporary lifting of import barriers in the direct aftermath of a disaster, increasing dramatically the speed of the deliveries of food and medicines in the immediate response phase. In addition, our results should also help bilateral and multilateral institutional donors, such as the Swiss Agency for Development and Cooperation (DDC), to increase their ability to assess the quality of the projects they finance. Indeed, through their privileged access to local governments and their strong negotiating power, such institutional donors have the ability to influence local governments of affected countries, and thus increase effectiveness and efficiency of their donations and ensure a better use of taxpayer money. Finally, this thesis provides organizations and donors with new insights on the funding of pre-disaster activities, and encourages them to invest in capabilities (e.g., process management) rather than physical inventories prepositioned in countries. By doing so, short lead times can be achieved in the immediate response following a disaster, at limited costs and risks.

In addition to the specific contributions of each paper composing the present work, this thesis as a whole also provides several contributions to academia and practice. Its main contribution is to analyse the same issue, governmental situational factors, from different angles. First it looks at the problem through the lens of existing literature (Section 4), then through the lens of practitioners interviewed through four case studies (Section 5), and finally through the lens of a researcher modelling the problem he observed in order to compare scenarios in a risk-free environment (Section 6). This multiple approach provides a more complete view of the problem under study, allowing the researcher as well as the readers to discover new facets of the issue while digging into the topic.

Although the thesis focuses on one type of situational factor, import barriers, its main value for academia is that it provides future researchers with a possible path for analysing and quantifying the effect of other situational factors on the performance of humanitarian logistics. Our three-step approach of first assessing the literature supported by a quantitative method, then conducting an explorative case study in order to get a better idea of the topic under study, and finally to quantify the effect through an empirical quantitative model, is therefore an interesting contribution in terms of research methodology.

For practice, the combination of the three papers of the thesis also provides a value. By making a link between issues recognized in literature and empirical problems, it demonstrates how an academic contribution can provide value for practitioners as well.

In addition, by providing an in-depth analysis of one particular topic following different approaches, it provides the reader with a deeper understanding of the problem than what could have been done in one single paper.

7.1. Limitations

This thesis is addressing one topic, the performance of humanitarian logistics, from different angles and through different methods. While we consider this multifaceted approach as an originality and strength of this work, it may also be its main limitation. Indeed, being structured as three different papers, the thesis lacks the in-depth focus which would have been possible to achieve in a standard monograph.

In addition, several limitations were identified in each section. In our meta-analysis of literature (Section 4), the decision to limit our selection of papers to highest quality academic journals only may have excluded interesting contributions such as books or practitioner oriented publications. The qualitative content analysis used to review the papers involved some subjective decisions, even though we tried to maximize objectivity through different means such as multiple coders and quantitative analysis based on word occurrences. Finally, the classification of papers according to four types of situational factors is a new concept, which has not been tested so far.

In the case study research on the effect of import barriers on humanitarian logistics (Section 5), we focused our in-depth analysis on one specific country, which limits the generalization of our findings to others contexts. Also, as we decided to concentrate on import barriers, there is a risk that we did not consider other forms of important governmental influences on humanitarian logistics. Finally, some of the assumptions made in this section are rather theoretical, which reduces the validity of some of the findings in the context of developing economies.

The research part using a simulation model (Section 6) has also some limitations. As our aim was to compare different scenarios in relative terms, we neglected some parameters such as transport time, and did not include any variability in the model. Because of a narrow focus on

a single disaster and single organization, we could not analyse effects of interactions between organizations. Furthermore, we concentrated on three extreme case scenarios, while the optimal solution certainly lies in between these scenarios. Finally, the validation of our model could have been improved by using historic data to perform statistical tests.

7.2. Further research

Further research directions proposed in our meta-analysis of literature (Section 4) were partially addressed in the subsequent sections of the thesis. In addition, we found that the logistics of continuous aid operations could be further analysed. Also, more attention could be given on slow onset, man-made disasters. Empirical methodologies such as case study research and surveys should be used more often. Regarding the phases of disasters, the reconstruction phase and its sustainability should be further studied.

The case study research on the effect of import barriers on humanitarian logistics (Section 5) showed that further research could analyse the impact of import barriers on medical items, which were not covered in this thesis due to their particular characteristics. It could also be analysed if import barriers during the rehabilitation phase produce additional positive side effects on humanitarian operation, such as the reduction of transportation and storage costs.

Finally, the last section using a simulation model (Section 6) could be further improved by analysing the costs involved in each scenario, in order to get a better estimate of the cost reduction potential of each preparedness scenario. Such a detailed analysis could for example include transport costs, which differ between scenarios. Also, variability could be included in the simulation model. Finally, further research could complement the extreme case scenarios we analysed with a middle case scenario consisting of the optimal mix of pre-positioning and investment in capabilities.

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9. References

Abbey, E. M. (2008), "Constructive regulation of non-government organizations". *The Quarterly Review of Economics and Finance,* Vol. 48, No. 2, pp. 370-376.

ABS (2010), "Academic Journal Quality Guide". Bristol, UK: Association of Business Schools. Available at: http://www.the-abs.org.uk/?id=257 (Accessed 09.08.2011).

Adivar, B. & Mert, A. (2010), "International disaster relief planning with fuzzy credibility". *Fuzzy Optimization and Decision Making,* Vol. 9, No. 4, pp. 413-433.

Aguilar, P. & Retamal, G. (2009), "Protective environments and quality education in humanitarian contexts". *International Journal of Educational Development,* Vol. 29, No. 1, pp. 3-16.

Albala-Bertrand, J. (2000), "Complex emergencies versus natural disasters: an analytical comparison of causes and effects". *Oxford Development Studies,* Vol. 28, No. 2, pp. 187-204.

Altay, N. & Green, W. G. (2006), "OR/MS research in disaster operations management". *European Journal of Operational Research,* Vol. 175, No. 1, pp. 475-493.

Altay, N., Prasad, S. & Sounderpandian, J. (2009), "Strategic planning for disaster relief logistics: lessons from supply chain management". *International Journal of Services Sciences,* Vol. 2, No. 2, pp. 142-161.

Atack, I. (1999), "Four criteria of development NGO legitimacy". *World Development,* Vol. 27, No. 5, pp. 855-864.

Balcik, B. & Beamon, B. M. (2008), "Facility location in humanitarian relief". *International Journal of Logistics: Research & Applications,* Vol. 11, No. 2, pp. 101-121.

Balcik, B., Beamon, B. M., Krejci, C. C., Muramatsu, K. M. & Ramirez, M. (2010), "Coordination in humanitarian relief chains: Practices, challenges and opportunities". *International Journal of Production Economics,* Vol. 126, No. 1, pp. 22-34.

Baldwin, R. E. (1969), "The case against infant-industry tariff protection". *The Journal of Political Economy,* Vol. 77, No. 3, pp. 295-305.

Banomyong, R., Beresford, A. & Pettit, S. (2009), "Logistics relief response model: the case of Thailand's tsunami affected area". *International Journal of Services Technology & Management,* Vol. 12, No. 4, pp. 414-429.

Banomyong, R. & Sopadang, A. (2010), "Using Monte Carlo simulation to refine emergency logistics response models: a case study". *International Journal of Physical Distribution & Logistics Management,* Vol. 40, No. 8, pp. 709-721.

Barbarosoglu, G. & Arda, Y. (2004), "A two-stage stochastic programming framework for transportation planning in disaster response". *Journal of the Operational Research Society,* Vol. 55, No. 1, pp. 43-53.

Barlas, Y. (1996), "Formal aspects of model validity and validation in system dynamics". *System dynamics review,* Vol. 12, No. 3, pp. 183-210.

Barratt, M., Choi, T. Y. & Li, M. (2011), "Qualitative case studies in operations management: Trends, research outcomes, and future research implications". *Journal of Operations Management,* Vol. 29, No. 4, pp. 329-342.

Beamon, B. M. & Balcik, B. (2008), "Performance measurement in humanitarian relief chains". *International Journal of Public Sector Management,* Vol. 21, No. 1, pp. 4-25.

Beamon, B. M. & Kotleba, S. A. (2006), "Inventory management support systems for emergency humanitarian relief operations in South Sudan". *International Journal of Logistics Management,* Vol. 17, No. 2, pp. 187-212.

Benini, A., Conley, C., Dittemore, B. & Waksman, Z. (2009), "Survivor needs or logistical convenience? Factors shaping decisions to deliver relief to earthquake-affected communities, Pakistan 2005–06". *Disasters,* Vol. 33, No. 1, pp. 110-131.

Benson, C., Twigg, J. & Myers, M. (2001), "NGO Initiatives in Risk Reduction: An Overview". *Disasters,* Vol. 25, No. 3, pp. 199-215.

Berelson, B. (1952), *Content analysis in communication research,* Glencoe, IL, The Free Press.

Besiou, M., Pedraza Martinez, A. & Van Wassenhove, L. (2012), The Effect of Earmarked Funding on Fleet Management for Relief and Development. *INSEAD working paper No 2012/10/TOM/ISIC.*

Besiou, M., Stapleton, O. & Van Wassenhove, L. N. (2011), "System dynamics for humanitarian operations". *Journal of Humanitarian Logistics and Supply Chain Management,* Vol. 1, No. 1, pp. 78-103.

Bratton, M. (1989), "The politics of government-NGO relations in Africa". *World Development,* Vol. 17, No. 4, pp. 569-587.

Brewerton, P. & Millward, L. (2001), *Organizational research methods: A guide for students and researchers,* London, Sage Publications Ltd.

Bryman, A. (2006), "Integrating quantitative and qualitative research: how is it done?". *Qualitative research,* Vol. 6, No. 1, pp. 97-113.

Campbell, A. M., Vandenbussche, D. & Hermann, W. (2008), "Routing for Relief Efforts". *Transportation Science,* Vol. 42, No. 2, pp. 127-145.

Chakravarty, A. K. (2011), "A contingent plan for disaster response". *International Journal of Production Economics,* Vol. 134, No. 1, pp. 3-15.

Chaney, T. (2008), "Distorted gravity: the intensive and extensive margins of international trade". *The American Economic Review,* Vol. 98, No. 4, pp. 1707-1721.

Charles, A. & Lauras, M. (2011), "An enterprise modelling approach for better optimisation modelling: application to the humanitarian relief chain coordination problem". *OR Spectrum,* Vol. 33, No. 3, pp. 815-841.

CNRS (2008), "Catégorisation des revues en Économie et en Gestion". Paris, FR: Comité National de la Recherche Scientifique. Available at: http://www.cnrs.fr/ (Accessed 09.08.2011).

Coston, J. M. (1998), "A model and typology of government-NGO relationships". *Nonprofit and Voluntary Sector Quarterly,* Vol. 27, No. 3, pp. 358-382.

Croom, S., Romano, P. & Giannakis, M. (2000), "Supply chain management: an analytical framework for critical literature review". *European journal of purchasing & supply management,* Vol. 6, No. 1, pp. 67-83.

Dadzie, K. Q. (1998), "Transfer of logistics knowledge to Third World countries". *International Journal of Physical Distribution & Logistics Management,* Vol. 28, No. 4, pp. 272-283.

Day, J. M., Junglas, I. & Silva, L. (2009), "Information Flow Impediments in Disaster Relief Supply Chains". *Journal of the Association for Information Systems,* Vol. 10, No. 8, pp. 637-660.

Day, J. M., Melnyk, S. A., Larson, P. D., Davis, E. W. & Whybark, D. C. (2012), "Humanitarian and Disaster Relief Supply Chains: A Matter of Life and Death". *Journal of Supply Chain Management,* Vol. 48, No. 2, pp. 21-36.

Denizel, M., Usdiken, B. & Tuncalp, D. (2003), "Drift or shift? Continuity, change, and international variation in knowledge production in OR/MS". *Operations Research,* Vol. 51, No. 5, pp. 711-720.

Denzin, N. K. & Lincoln, Y. S. (1994), *Handbook of qualitative research,* Thousand Oaks, CA & London, Sage Pub.

Downs, A. (1957), "An economic theory of political action in a democracy". *The Journal of Political Economy,* Vol. 65, No. 2, pp. 135-150.

Dowty, R. A. & Wallace, W. A. (2010), "Implications of organizational culture for supply chain disruption and restoration". *International Journal of Production Economics,* Vol. 126, No. 1, pp. 57-65.

Duran, S., Gutierrez, M. A. & Keskinocak, P. (2011), "Pre-Positioning of Emergency Items for CARE International". *Interfaces,* Vol. 41, No. 3, pp. 223-237.

Duriau, V. J., Reger, R. K. & Pfarrer, M. D. (2007), "A content analysis of the content analysis literature in organization studies: Research themes, data sources, and methodological refinements". *Organizational Research Methods,* Vol. 10, No. 1, pp. 5-34.

Eisenhardt, K. M. (1989), "Building Theories from Case Study Research". *Academy of Management Review,* Vol. 14, No. 4, pp. 532-550.

Ergun, Ö., Heier Stamm, J. L., Keskinocak, P. & Swann, J. L. (2010), "Waffle House Restaurants hurricane response: A case study". *International Journal of Production Economics,* Vol. 126, No. 1, pp. 111-120.

Forrester, J. W. (1961), *Industrial dynamics,* Cambridge, MA, Productivity Press.

Forrester, J. W. (1994), Policies, decisions and information sources for modeling. *In:* Morecroft, J. D. W. & Sterman, J. D. (eds.) *Modeling for Learning Organizations.* Portland, OR: Productivity Press.

Forza, C. (2002), "Survey research in operations management: a process-based perspective". *International Journal of Operations & Production Management,* Vol. 22, No. 2, pp. 152-194.

Freedom House (2010), Freedom in the World 2010. Washington D.C.: Freedom House.

Gatignon, A., Van Wassenhove, L. N. & Charles, A. (2010), "The Yogyakarta earthquake: Humanitarian relief through IFRC's decentralized supply chain". *International Journal of Production Economics,* Vol. 126, No. 1, pp. 102-110.

Gibbert, M. & Ruigrok, W. (2010), "The ‘‘What’’and ‘‘How’’of Case Study Rigor: Three Strategies Based on Published Work". *Organizational Research Methods,* Vol. 13, No. 4, pp. 710.

Gibbert, M., Ruigrok, W. & Wicki, B. (2008), "What passes as a rigorous case study?". *Strategic Management Journal,* Vol. 29, No. 13, pp. 1465-1474.

Gibbons, D. E. & Samaddar, S. (2009), "Designing Referral Network Structures and Decision Rules to Streamline Provision of Urgent Health and Human Services". *Decision Sciences,* Vol. 40, No. 2, pp. 351-371.

Giunipero, L. C., Hooker, R. E., Joseph-Matthews, S., Yoon, T. E. & Brudvig, S. (2008), "A decade of SCM literature: Past, present and future implications". *Journal of Supply Chain Management,* Vol. 44, No. 4, pp. 66-86.

Goldsby, T. J. & García-Dastugue, S. J. (2003), "The manufacturing flow management process". *International Journal of Logistics Management, The,* Vol. 14, No. 2, pp. 33-52.

Gonçalves, P. (2008), "System Dynamics Modeling of Humanitarian Relief Operations". MIT Sloan research. paper no. 4704-08. Available at: http://papers.ssrn.com/abstract=1139817 (Accessed 16.08.2012).

Gonçalves, P. (2011), "Balancing provision of relief and recovery with capacity building in humanitarian operations". *Operations Management Research,* Vol. 4, No. 1, pp. 39-50.

Görmez, N., Köksalan, M. & Salman, F. S. (2011), "Locating disaster response facilities in Istanbul". *Journal of the Operational Research Society*, Vol. 62, No. 7, pp. 1239-1252.

Grether, J.-M., de Melo, J. & Olarreaga, M. (2001), "Who determines Mexican trade policy?". *Journal of Development Economics*, Vol. 64, No. 2, pp. 343-370.

Hale, T. & Moberg, C. R. (2005), "Improving supply chain disaster preparedness: A decision process for secure site location". *International Journal of Physical Distribution & Logistics Management*, Vol. 35, No. 3, pp. 195-207.

Herlin, H. & Pazirandeh, A. (2012), "Nonprofit organizations shaping the market of supplies". *International Journal of Production Economics*, Vol. 139, No. 2, pp. 411-421.

Holguín-Veras, J., Jaller, M., Van Wassenhove, L. N., Pérez, N. & Wachtendorf, T. (2012), "On the unique features of post-disaster humanitarian logistics". *Journal of Operations Management*, Vol. 30, No. 7–8, pp. 494-506.

Horner, M. W. & Downs, J. A. (2010), "Optimizing hurricane disaster relief goods distribution: model development and application with respect to planning strategies". *Disasters*, Vol. 34, No. 3, pp. 821-844.

Howard, M. M. & Roessler, P. G. (2006), "Liberalizing electoral outcomes in competitive authoritarian regimes". *American Journal of Political Science*, Vol. 50, No. 2, pp. 365-381.

Hu, Z.-H. (2011), "A container multimodal transportation scheduling approach based on immune affinity model for emergency relief". *Expert Systems with Applications*, Vol. 38, No. 3, pp. 2632-2639.

Jahangirian, M., Eldabi, T., Naseer, A., Stergioulas, L. K. & Young, T. (2010), "Simulation in manufacturing and business: A review". *European Journal of Operational Research*, Vol. 203, No. 1, pp. 1-13.

Jahre, M. & Heigh, I. (2008), "Does the Current Constraints in Funding Promote Failure in Humanitarian Supply Chains?". *Supply Chain Forum: An International Journal*, Vol. 9, No. 2, pp. 44-54.

Jahre, M., Jensen, L. M. & Listou, T. (2009), "Theory development in humanitarian logistics: a framework and three cases". *Management Research News*, Vol. 32, No. 11, pp. 1008-1023.

JHLSCM (2011), "Journal of Humanitarian Logistics and Supply Chain Management". Emerald Insight. Available at: www.emeraldinsight.com/2042-6747.htm (Accessed 16/11/2010).

Kalyvitis, S. & Vlachaki, I. (2012), "When does more aid imply less democracy? An empirical examination". *European Journal of Political Economy*, Vol. 28, No. 1, pp. 132–146.

Kandiyoti, D. (2007), "Old Dilemmas or New Challenges? The Politics of Gender and Reconstruction in Afghanistan". *Development and Change*, Vol. 38, No. 2, pp. 169-199.

Karlsson, C. (2008), *Researching operations management*, Oxon, Routledge.

Kotzab, H., Seuring, S., Müller, M. & Reiner, G. (2005), *Research Methodologies in Supply Chain Management*, Heidelberg, Physica-Verlag HD.

Kovács, G., Matopoulos, A. & Hayes, O. (2010), "A community-based approach to supply chain design". *International Journal of Logistics: Research and Applications*, Vol. 13, No. 5, pp. 411-422.

Kovács, G. & Spens, K. M. (2007), "Humanitarian logistics in disaster relief operations". *International Journal of Physical Distribution & Logistics Management*, Vol. 37, No. 2, pp. 99-114.

Kovács, G. & Spens, K. M. (2009), "Identifying challenges in humanitarian logistics". *International Journal of Physical Distribution & Logistics Management*, Vol. 39, No. 6, pp. 506-528.

Kovács, G. & Spens, K. M. (2011a), "Humanitarian logistics and supply chain management: the start of a new journal". *Journal of Humanitarian Logistics and Supply Chain Management*, Vol. 1, No. 1, pp. 5-14.

Kovács, G. & Spens, K. M. (2011b), "Trends and developments in humanitarian logistics – a gap analysis". *International Journal of Physical Distribution & Logistics Management,* Vol. 41, No. 1, pp. 32-45.

Kovács, G. & Tatham, P. (2009a), "Humanitarian logistics performance in the light of gender". *International Journal of Productivity and Performance Management,* Vol. 58, No. 2, pp. 174-187.

Kovács, G. & Tatham, P. (2009b), "Responding to disruptions in the supply network - From dormant to action". *Journal of Business Logistics,* Vol. 30, No. 2, pp. 215-229.

Kovács, G. & Tatham, P. (2010), "What is special about a humanitarian logistician? A survey of logistic skills and performance". *Supply Chain Forum: An International Journal,* Vol. 11, No. 3, pp. 32-41.

Krugman, P. & Obstfeld, M. (2006), *International Economics, Theory and Policy*, Boston, MA, Pearson.

Kunz, N. & Reiner, G. The ambiguous role of governments in humanitarian logistics. *Working paper.*

Kunz, N. & Reiner, G. (2011), Humanitarian Logistics Operations: A Review. *In:* Sucky, E., Asdecker, B., Dobhan, A., Haas, S. & Wiese, J. (eds.) *Logistikmanagement : Herausforderungen, Chancen & Lösungen.* Bamberg, DE: Univ. of Bamberg Press.

Kunz, N. & Reiner, G. (2012a), The ambivalent role of governments in humanitarian supply chains. *In:* Grubbström, R. W. & Hinterhuber, H. H., eds. Seventeenth International Working Seminar on Production Economics, February 20-24 2012a Innsbruck, AT. 121-132.

Kunz, N. & Reiner, G. (2012b), "A meta-analysis of Humanitarian Logistics research". *Journal of Humanitarian Logistics and Supply Chain Management,* Vol. 2, No. 2, pp. 116-147.

Kunz, N., Reiner, G. & Gold, S. Capabilities investment versus pre-positioning inventory: A new approach to disaster preparedness. *Working paper under review at International Journal of Production Economics.*

Lall, S. (2001), "Competitiveness indices and developing countries: an economic evaluation of the Global Competitiveness Report". *World Development,* Vol. 29, No. 9, pp. 1501-1525.

Landis, J. R. & Koch, G. G. (1977), "The measurement of observer agreement for categorical data". *Biometrics,* Vol. 33, No. 1, pp. 159-174.

Lee, H. L. & Whang, S. (2005), "Higher supply chain security with lower cost: Lessons from total quality management". *International Journal of Production Economics,* Vol. 96, No. 3, pp. 289-300.

Leon, E., Kelman, I., Kennedy, J. & Ashmore, J. (2009), "Capacity Building Lessons From a Decade of Transitional Settlement and Shelter". *International Journal of Strategic Property Management,* Vol. 13, No. 3, pp. 247-265.

Lin, J., Chai, K. H., Wong, Y. S. & Brombacher, A. C. (2008), "A dynamic model for managing overlapped iterative product development". *European Journal of Operational Research,* Vol. 185, No. 1, pp. 378-392.

Linnerooth-Bayer, J., Mechler, R. & Pflug, G. (2005), "Refocusing disaster aid". *Science,* Vol. 309, No. 5737, pp. 1044-1046.

List, F. (1904), *National system of political economy*, London, Longmans, Green.

Listou, T. (2008), "Postponement and Speculation in Noncommercial Supply Chains". *Supply Chain Forum: International Journal,* Vol. 9, No. 2, pp. 56-64.

Lodree, E. J. & Taskin, S. (2009), "Supply chain planning for hurricane response with wind speed information updates". *Computers and Operations Research,* Vol. 36, No. 1, pp. 2-15.

Logistics Cluster (2012), "Logistics Cluster". Rome: UNWFP. Available at: http://www.logcluster.org (Accessed 17.09.2012).

Long, D. C. & Wood, D. F. (1995), "The Logistics of Famine Relief". *Journal of Business Logistics,* Vol. 16, No. 1, pp. 213-229.

Majewski, B., Navangul, K. A. & Heigh, I. (2010), "A Peek into the Future of Humanitarian Logistics: Forewarned Is Forearmed". *Supply Chain Forum: An International Journal,* Vol. 11, No. 3, pp. 4-19.

Maon, F., Lindgreen, A. & Vanhamme, J. (2009), "Developing supply chains in disaster relief operations through cross-sector socially oriented collaborations: a theoretical model". *Supply Chain Management,* Vol. 14, No. 2, pp. 149-164.

Marshall, M. & Cole, B. (2011), Global Report 2011. *Conflict, Governance and State Fragility.* Polity IV Project.

Marshall, M. G. & Jaggers, K. (2002), Polity IV project: Political regime characteristics and transitions. Arlington, VA: Center for Global Policy, George Mason University.

Mayring, P. (2000), "Qualitative Content Analysis". *Forum Qualitative Sozialforschung / Forum: Qualitative Social Research,* Vol. 1, No. 2.

Mayring, P. (2002), *Einführung in die qualitative Sozialforschung - Eine Anleitung zum qualitativen Denken (Introduction to Qualitative Social Research),* Weinheim and Basel, Beltz Verlag.

McCoy, J. (2008), "Humanitarian response: improving logistics to save lives". *American journal of disaster medicine,* Vol. 3, No. 5, pp. 283-293.

McLachlin, R. & Larson, P. D. (2011), "Building humanitarian supply chain relationships: lessons from leading practitioners". *Journal of Humanitarian Logistics and Supply Chain Management,* Vol. 1, No. 1, pp. 32-49.

Melo, J. D. & Grether, J.-M. (2000), *Commerce international: théories et applications,* Paris, Bruxelles, De Boeck Université.

Mentzer, J. T. & Konrad, B. P. (1991), "An efficiency/effectiveness approach to logistics performance analysis". *Journal of business logistics,* Vol. 12, No. 1, pp. 33-62.

Meredith, J. (1998), "Building operations management theory through case and field research". *Journal of Operations Management,* Vol. 16, No. 4, pp. 441-454.

Mete, H. O. & Zabinsky, Z. B. (2010), "Stochastic optimization of medical supply location and distribution in disaster management". *International Journal of Production Economics,* Vol. 126, No. 1, pp. 76-84.

Miles, M. B. & Huberman, A. M. (1994), *Qualitative data analysis: an expanded sourcebook,* Thousand Oaks, CA, Sage Pub.

Mill, J. S. (1909), *The Principles of Political Economy,* London, Longmans, Green.

Miser, H. J. & Quade, E. S. (1988), Validation. *In:* Miser, H. J. & Quade, E. S. (eds.) *Handbook of system analysis - craft issues and procedural choices.* NewYork: Wiley.

Murray, S. (2005), How to deliver on the promises. *Financial Times,* 07.01.05, p.9.

Natarajarathinam, M., Capar, I. & Narayanan, A. (2009), "Managing supply chains in times of crisis: a review of literature and insights". *International Journal of Physical Distribution & Logistics Management,* Vol. 39, No. 7, pp. 535-573.

Nolz, P., Doerner, K. F. & Hartl, R. F. (2010), "Water distribution in disaster relief". *International Journal of Physical Distribution & Logistics Management,* Vol. 40, No. 8, pp. 693-708.

Nolz, P., Semet, F. & Doerner, K. F. (2011), "Risk approaches for delivering disaster relief supplies". *OR Spectrum,* Vol. 33, No. 3, pp. 543-569.

North, L. L. & Cameron, J. D. (2000), "Grassroots-based rural development strategies: Ecuador in comparative perspective". *World Development,* Vol. 28, No. 10, pp. 1751-1766.

Nutriset (2012), "Website of Nutriset, the producer of Plumpy'Nut Ready to Use Therapeutic Food". NUTRISET SA. Available at: http://www.nutriset.fr (Accessed 17.07.2012).

Oliva, R. & Sterman, J. D. (2001), "Cutting corners and working overtime: Quality erosion in the service industry". *Management Science,* Vol. 47, No. 7, pp. 894-914.

Oloruntoba, R. (2010), "An analysis of the Cyclone Larry emergency relief chain: Some key success factors". *International Journal of Production Economics,* Vol. 126, No. 1, pp. 85-101.

Oloruntoba, R. & Gray, R. (2006), "Humanitarian aid: an agile supply chain?". *Supply Chain Management: An International Journal,* Vol. 11, No. 2, pp. 115-120.

Olson, J. E. (2005), "Top-25-Business-School Professors Rate Journals in Operations Management and Related Fields". *Interfaces,* Vol. 35, No. 4, pp. 323-338.

Overstreet, R. E., Hall, D., Hanna, J. B. & Rainer Jr, R. K. (2011), "Research in humanitarian logistics". *Journal of Humanitarian Logistics and Supply Chain Management,* Vol. 1, No. 2, pp. 114-131.

Özdamar, L. (2011), "Planning helicopter logistics in disaster relief". *OR Spectrum,* Vol. 33, No. 3, pp. 655-672.

Patton, M. Q. (2002), *Qualitative research and evaluation methods,* Thousand Oaks, CA, Sage.

Pazirandeh, A. (2011), "Sourcing in global health supply chains for developing countries". *International Journal of Physical Distribution & Logistics Management,* Vol. 41, No. 4, pp. 364-384.

Pedraza-Martinez, A. J., Stapleton, O. & Van Wassenhove, L. N. (2011), "Field vehicle fleet management in humanitarian operations: A case-based approach". *Journal of Operations Management,* Vol. 29, No. 5, pp. 404-421.

Pedraza-Martinez, A. J. & Van Wassenhove, L. N. (2012), "Vehicle Replacement in the International Committee of the Red Cross". *Production and Operations Management,* Vol. XX, No. XX, pp. 1-12.

Perry, M. (2007), "Natural disaster management planning: A study of logistics managers responding to the tsunami". *International Journal of Physical Distribution & Logistics Management,* Vol. 37, No. 5, pp. 409-433.

Pettit, S. & Beresford, A. (2009), "Critical success factors in the context of humanitarian aid supply chains". *International Journal of Physical Distribution & Logistics Management,* Vol. 39, No. 6, pp. 450-468.

Pettit, S. J. & Beresford, A. K. C. (2005), "Emergency relief logistics: an evaluation of military, non-military and composite response models". *International Journal of Logistics: Research & Applications,* Vol. 8, No. 4, pp. 313-331.

Pillon, C. (2012), General information on Plumpy'Nut, from Supply Chain Manager of Nutriset. Email to Kunz, N.

Popper, K. (1959), *The logic of scientific discovery,* Tuebingen, Hutchinson.

Rao, S. & Goldsby, T. J. (2009), "Supply chain risks: a review and typology". *International Journal of Logistics Management, The,* Vol. 20, No. 1, pp. 97-123.

Rawls, C. G. & Turnquist, M. A. (2010), "Pre-positioning of emergency supplies for disaster response". *Transportation research part B: Methodological,* Vol. 44, No. 4, pp. 521-534.

Reiner, G. (2004), Supply chain performance measurement with customer satisfaction and uncertainties. *In:* Spengler, T., Voss, S. & Kopfer, H. (eds.) *Logistik Management: Prozesse–Systeme–Ausbildung, Heidelberg.* Heidelberg: Physika-Verlag.

Reiner, G. & Natter, M. (2007), "An encompassing view on markdown pricing strategies: an analysis of the Austrian mobile phone market". *OR Spectrum,* Vol. 29, No. 1, pp. 173-192.

Reiner, G., Natter, M. & Drechsler, W. (2009), "Life cycle profit - reducing supply risks by integrated demand management". *Technology Analysis & Strategic Management,* Vol. 21, No. 5, pp. 653-664.

Reisman, A. & Kirschnick, F. (1994), "The devolution of OR/MS: Implications from a statistical content analysis of papers in flagship". *Operations Research,* Vol. 42, No. 4, pp. 577-588.

Rodrik, D. (1995), The political economy of trade policy. *In:* Grossman, G. & Rogoff, K. (eds.) *Handbook of International Economics.* Amsterdam: North-Holland.

Rottkemper, B., Fischer, K., Blecken, A. & Danne, C. (2011), "Inventory relocation for overlapping disaster settings in humanitarian operations". *OR Spectrum,* Vol. 33, No. 3, pp. 721-749.

Ryan, G. W. & Bernard, H. R. (2000), Data Management and Analysis Methods. *In:* Denzin, N. K. & Lincoln, Y. S. (eds.) *Handbook of Qualitative Research.* Thousand Oaks, CA: Sage.

Salmerón, J. & Apte, A. (2010), "Stochastic Optimization for Natural Disaster Asset Prepositioning". *Production and Operations Management,* Vol. 19, No. 5, pp. 561-574.

Samuelson, P. A. & Nordhaus, W. D. (2009), *Economics,* New York, NY, Mcgraw-Hill Higher Education.

Sandwell, C. (2011), "A qualitative study exploring the challenges of humanitarian organisations". *Journal of Humanitarian Logistics and Supply Chain Management,* Vol. 1, No. 2, pp. 132-150.

Santos, S. P., Belton, V. & Howick, S. (2002), "Adding value to performance measurement by using system dynamics and multicriteria analysis". *International Journal of Operations & Production Management,* Vol. 22, No. 11, pp. 1246-1272.

Saunders, M., Lewis, P. & Thornhill, A. (2009), *Research methods for business students,* Harlow, Pearson Education.

Schodl, R., Kunz, N., Reiner, G. & Santos, G. G. (2010), Improving Business Processes with Rapid Modeling: the Case of Digger. *In:* Reiner, G. (ed.) *Rapid Modelling and Quick Response.* London: Springer.

Schulz, S. F. & Blecken, A. (2010), "Horizontal cooperation in disaster relief logistics: benefits and impediments". *International Journal of Physical Distribution & Logistics Management,* Vol. 40, No. 8/9, pp. 636-656.

Seekins, D. M. (2009), "State, Society and Natural Disaster: Cyclone Nargis in Myanmar (Burma)". *Asian Journal of Social Science,* Vol. 37, No. 5, pp. 717-737.

Seuring, S., Müller, M., Westhaus, M. & Morana, R. (2005), Conducting a Literature Review-The Example of Sustainability in Supply Chains. *In:* Kotzab, H., Seuring, S., Müller, M. & Reiner, G. (eds.) *Research Methodologies in Supply Chain Management.* Heidelberg: Physica-Verlag HD.

Seuring, S. A. (2008), "Assessing the rigor of case study research in supply chain management". *Supply Chain Management: An International Journal,* Vol. 13, No. 2, pp. 128-137.

Seybolt, T. B. (2009), "Harmonizing the humanitarian aid network: adaptive change in a complex system". *International Studies Quarterly,* Vol. 53, No. 4, pp. 1027-1050.

Shapiro, G. & Markoff, G. (1997), Methods for drawing statistical inferences from texts and transcripts. *In:* Roberts, C. W. (ed.) *Text analysis for the social sciences.* Mahwah, NJ: Lawrence Erlbaum Associates.

Sheu, J.-B. (2007), "Challenges of emergency logistics management". *Transportation Research: Part E,* Vol. 43, No. 6, pp. 655-659.

Sheu, J.-B. (2010), "Dynamic relief-demand management for emergency logistics operations under large-scale disasters". *Transportation Research: Part E,* Vol. 46, No. 1, pp. 1-17.

Silverman, D. (2005), *Doing qualitative research,* London, Sage Publications Ltd.

Slack, N. & Lewis, M. (2002), *Operations strategy,* Englewood Cliffs, NJ, FT/Prentice Hall.

Smirnov, A., Levashova, T., Pashkin, M., Shilov, N. & Komarova, A. (2007), "Disaster response based on production network management tasks". *Management Research News,* Vol. 30, No. 11, pp. 829-842.

Spens, K. M. & Kovács, G. (2006), "A content analysis of research approaches in logistics research". *International Journal of Physical Distribution & Logistics Management,* Vol. 36, No. 5, pp. 374-390.

Stephenson, M. (2005), "Making humanitarian relief networks more effective: operational coordination, trust and sense making". *Disasters,* Vol. 29, No. 4, pp. 337-350.

Sterman, J. D. (1989), "Modeling Managerial Behavior: Misperceptions of Feedback in a Dynamic Decision Making Experiment". *Management Science,* Vol. 35, No. 3, pp. 321-339.

Sterman, J. D. (1991), A skeptic's guide to computer models. *In:* Barney, G. O., Kreutzer, W. B. & Garrett, M. J. (eds.) *Managing a Nation: The Microcomputer Software Catalog.* Boulder, CO: Westview Press.

Sterman, J. D. (2000), *Business dynamics: Systems thinking and modeling for a complex world,* New York, Irwin/McGraw-Hill.

Stuart, I., McCutcheon, D., Handfield, R., McLachlin, R. & Samson, D. (2002), "Effective case research in operations management: a process perspective". *Journal of Operations Management,* Vol. 20, No. 5, pp. 419-433.

Tashakkori, A. (2006), *Mixed methodology: Combining qualitative and quantitative approaches,* Thousand Oaks, CA, Sage.

Taskin, S. & Lodree, E. J. (2010), "Inventory decisions for emergency supplies based on hurricane count predictions". *International Journal of Production Economics,* Vol. 126, No. 1, pp. 66-75.

Taskin, S. & Lodree, E. J. (2011), "A Bayesian decision model with hurricane forecast updates for emergency supplies inventory management". *Journal of the Operational Research Society,* Vol. 62, No. 6, pp. 1098-1108.

Tatham, P. (2009), "An investigation into the suitability of the use of unmanned aerial vehicle systems (UAVS) to support the initial needs assessment process in rapid onset humanitarian disasters". *International Journal of Risk Assessment & Management,* Vol. 13, No. 1, pp. 60-78.

Tatham, P. (2012), "Bibliography on Humanitarian Logistics". HUMLOG Institute. Available at: http://www.hanken.fi/public/en/humlogbibliography (Accessed 31.01.2012).

Tatham, P. & Houghton, L. (2011), "The wicked problem of humanitarian logistics and disaster relief aid". *Journal of Humanitarian Logistics and Supply Chain Management,* Vol. 1, No. 1, pp. 15-31.

Tatham, P. & Kovács, G. (2010), "The application of "swift trust" to humanitarian logistics". *International Journal of Production Economics,* Vol. 126, No. 1, pp. 35-45.

Tatham, P. & Pettit, S. (2010), "Transforming humanitarian logistics: the journey to supply network management". *International Journal of Physical Distribution & Logistics Management,* Vol. 40, No. 8/9, pp. 609-622.

The World Bank (2012), Doing Business database. Washington D.C.: The World Bank.

Thévenaz, C. & Resodihardjo, S. L. (2010), "All the best laid plans…conditions impeding proper emergency response". *International Journal of Production Economics,* Vol. 126, No. 1, pp. 7-21.

Thomas, A. & Fritz, L. (2006), "Disaster relief, inc". *Harvard business review*, Vol. 84, No. 11, pp. 114-122.

Thomas, A. S. & Kopczak, L. R. (2005), From logistics to supply chain management: the path forward in the humanitarian sector. San Francisco, CA: Fritz Institute.

Thomson Reuters (2010), "Journal Citation Report 2010". Thompson Reuters. Available at: http://admin-apps.isiknowledge.com/JCR/JCR (Accessed 20.01.2012 2012).

Tinguaro Rodríguez, J., Vitoriano, B. & Montero, J. (2012), "A general methodology for data-based rule building and its application to natural disaster management". *Computers and Operations Research*, Vol. 39, No. 4, pp. 863-873.

Tomasini, R. & Van Wassenhove, L. (2009a), *Humanitarian logistics*, Palgrave Macmillan.

Tomasini, R. M. & Van Wassenhove, L. N. (2003), Coordinating Disaster Logistics After El Salvador's Earthquakes Using SUMAS's Humanitarian Supply Management System. Fontainebleau: INSEAD.

Tomasini, R. M. & Van Wassenhove, L. N. (2004), "Pan-American health organization's humanitarian supply management system: de-politicization of the humanitarian supply chain by creating accountability". *Journal of Public Procurement*, Vol. 4, No. 3, pp. 437-449.

Tomasini, R. M. & Van Wassenhove, L. N. (2009b), "From preparedness to partnerships: case study research on humanitarian logistics". *International Transactions in Operational Research*, Vol. 16, No. 5, pp. 549-559.

Tovia, F. (2007), "An emergency logistics response system for natural disasters". *International Journal of Logistics Research and Applications*, Vol. 10, No. 3, pp. 173-186.

Transparency International (2011), "Corruption Perception Index". (Accessed 21.12.2011).

Trautsamwieser, A., Gronalt, M. & Hirsch, P. (2011), "Securing home health care in times of natural disasters". *OR Spectrum*, Vol. 33, No. 3, pp. 787-813.

Trunick, P. A. (2005), "Delivering relief to tsunami victims". *Logistics Today*, Vol. 46, No. 2, pp. 1-9.

Tzeng, G.-H., Cheng, H.-J. & Huang, T. D. (2007), "Multi-objective optimal planning for designing relief delivery systems". *Transportation Research: Part E*, Vol. 43, No. 6, pp. 673-686.

Ukkusuri, S. V. & Yushimito, W. F. (2008), "Location routing approach for the humanitarian prepositioning problem". *Transportation Research Record*, Vol. 2089, No. 1, pp. 18-25.

Van der Laan, E. A., De Brito, M. P., Van Fenema, P. C. & Vermaesen, S. C. (2009), "Managing information cycles for intra-organisational coordination of humanitarian logistics". *International Journal of Services Technology & Management*, Vol. 12, No. 4, pp. 362-390.

Van Wassenhove, L. N. (2006), "Blackett Memorial Lecture Humanitarian aid logistics: supply chain management in high gear". *Journal of the Operational Research Society*, Vol. 57, No. 5, pp. 475-489.

Vensim (2012), "Vensim Help". Available at: https://www.vensim.com/documentation/index.html?fn_queue_age_oldest.htm (Accessed 19.12.2012).

VHB (2011), "VHB-JOURQUAL 2.1 - Gesamtübersicht". Göttingen, GE: German Academic Association for Business Research. Available at: http://vhbonline.org/service/jourqual/vhb-jourqual-21-2011/jq21/ (Accessed 09.08.2011).

Vitoriano, B., Ortuño, M., Tirado, G. & Montero, J. (2011), "A multi-criteria optimization model for humanitarian aid distribution". *Journal of Global Optimization*, Vol. 51, No. 2, pp. 189-208.

Voss, C. A., Frohlich, M. & Tsikriktsis, N. (2002), "Case research in operations management". *International Journal of Operations and Production Management*, Vol. 22, No. 2, pp. 195-219.

Walker, H. & Harland, C. (2008), "E-procurement in the United Nations: influences, issues and impact". *International Journal of Operations & Production Management*, Vol. 28, No. 9, pp. 831-857.

Wang, Y., Gilland, W. & Tomlin, B. (2011), "Regulatory Trade Risk and Supply Chain Strategy". *Production and Operations Management*, Vol. 20, No. 4, pp. 522-540.

Weber, R. P. (1990), *Basic content analysis*, Newbury Park, Sage.

WFP (2004), "WFP sends world's biggest cargo plane with aid for Haitian flood victims". Rome: World Food Programme. Available at: www.wfp.org/news/news-release/wfp-sends-worlds-biggest-car (Accessed 18.07.2012).

Whiting, M. C. & Ayala-Öström, B. E. (2009), "Advocacy to promote logistics in humanitarian aid". *Management Research News*, Vol. 32, No. 11, pp. 1081-1089.

Whybark, D. C. (2007), "Issues in managing disaster relief inventories". *International Journal of Production Economics*, Vol. 108, No. 1/2, pp. 228-235.

Yadav, P. (2007), Analysis of the Public, Private and Mission Sector Supply Chains for Essential Drugs in Zambia. London: DFID.

Yadav, P. (2010), Differential pricing for pharmaceuticals. London: DFID.

Yan, S. & Shih, Y.-L. (2009), "Optimal scheduling of emergency roadway repair and subsequent relief distribution". *Computers and Operations Research*, Vol. 36, No. 6, pp. 2049-2065.

Yi, W. & Özdamar, L. (2007), "A dynamic logistics coordination model for evacuation and support in disaster response activities". *European Journal of Operational Research*, Vol. 179, No. 3, pp. 1177-1193.

Yin, R. K. (2009), *Case study research: Design and methods*, Thousand Oaks, CA, Sage Pub.

10.Appendixes

Appendix A: Characteristics, findings and proposed future research of previous literature reviews

Criteria	**Altay and Green (2006)**	**Kovács and Spens (2007)**	**Natarajarathinam *et al*. (2009)**	**Pettit and Beresford (2009)**	**Overstreet *et al.* (2011)**
Scope	OR/MS literature in disaster operations management	Literature on humanitarian logistics	Literature of supply chain management (SCM) in times of crisis	Literature about critical success factors in the commercial context	Literature on humanitarian logistics, sudden onset disasters
Database used	- ISI Web of Science - IFORS search engine - Business Source Premier - Cambridge Sientific Abstracts IDS - Compendenx Engineering Village 2 - Scirus - Econbase - Civil Engineering Database - Scitation - SciFinder	several journal databases	- ProQuest - ABI/Inform - EBSCO - ScienceDirect	not specified	- EBSCOHOST - ABI/Informs - Academic Search Premier - Google Scholar

Criteria	**Altay and Green (2006)**	**Kovács and Spens (2007)**	**Natarajarathinam *et al.* (2009)**	**Pettit and Beresford (2009)**	**Overstreet *et al.* (2011)**
Keywords	- disaster - emergency - catastrophe - extreme event - disastrous - catastrophic	- humanitarian AND logistics - humanitarian aid AND supply chains - disaster relief AND logistics - disaster relief AND supply chains - emergency AND logistics - emergency AND supply chains	- crisis - risks - disaster - uncertainty - emergency - disruption - catastrophe - crisis management - risk management - disastrous - catastrophic	not specified	- logistics OR supply chain management AND disaster OR emergency OR humanitarian OR relief
Classification of papers?	yes	no	yes	no	yes
If yes, which categories?	- phase of disaster - research methodology - research contribution - cause of disaster - publication period - problem scenario		- source of crisis - scale of crisis - phase of crisis management - research methodology - type of respondent to crisis		- complexities - personnel - equipment - infrastructure - information technology - planning, policies and procedures - proposed models - areas for further research

Criteria	**Altay and Green (2006)**	**Kovács and Spens (2007)**	**Natarajarathinam *et al*. (2009)**	**Pettit and Beresford (2009)**	**Overstreet *et al.* (2011)**
Findings	- mathematical programming is most frequently used method - system dynamics, constraint programming and soft OR techniques are underused - most papers in mitigation phase address man-made disasters - only few papers in main-stream OR journals are on natural disasters - no humanitarian disasters (epidemics, famine, war, genocide) addressed in OR/MS related journals - more than 50% of research is on model development, 26.6% on theory development and 15.6% on application	- literature focuses on the preparation phase - few papers concentrate on the immediate response phase - humanitarian world has insufficient investment in technologies, communication and modelling techniques - shortage of logistics experts in humanitarian logistics - supply chain processes are largely manual - basic principles of business logistics can be applied in humanitarian logistics	- increase in number of publications in the last years - more research has been done for crisis caused by external sources than internal sources - increase of number of paper focusing on several phases of disaster management - more research on mitigation and preparation than response and reconstruction phases - few research on the recovery of a supply chain after crisis - limited empirical studies - many analytical research using OR techniques - applied research and models developed are specific to particular crisis situations	- critical success factors from commercial context are equally important in the humanitarian aid context - cultural elements and political constraints play an important role in decision making in humanitarian aid context - effectiveness of a humanitarian supply chains is determined by structural or cultural factors	- foundations for a core body of knowledge in humanitarian logistics have been laid in literature - most humanitarian literature concentrates on preparation or planning phase - most authors recommend further research on planning, policies and procedures

Criteria	**Altay and Green (2006)**	**Kovács and Spens (2007)**	**Natarajarathinam *et al*. (2009)**	**Pettit and Beresford (2009)**	**Overstreet *et al.* (2011)**
Proposed steps for future research	- do more research on reconstruction phase - develop mitigation tools - develop theory on preparation, response and reconstruction phases - do more research on management consulting research for recovery efforts - develop measures of productivity and efficiency - develop better understanding of inputs for models - use new methodologies such as system dynamics, fuzzy systems, soft OR - more multi-agency research, considering political issues - more research on business continuity after disaster - more research on resilient infrastructure and network design	- do more research on response and reconstruction phases - do more research on planning and execution of operations in disaster relief - do more research on links and similarities between humanitarian logistics and business logistics	- do more research on reconstruction phase - develop scales for level of crisis management - do more research on robustness and resilience of supply chains - do more case studies and empirical research in crisis management for not-for-profit supply chains - do more research on supply chain management crisis arising from internal sources - do more research on non-profit organizations and humanitarian organizations, through case studies	- test the critical success factors proposed in the study through qualitative research in the context of humanitarian aid	- do more research on organization's personnel: recruiting, training, retaining, deploying personnel - do more research on equipment: purchasing, positioning, deploying resources - do more research on infrastructure: methods to overcome non-availability of roads, rail, bridges - do more research on transportation: last mile distribution - do more research on information technology/com-munication: use of common use software and hardware - do more research on inventory management: quantity and location of prepositioning supplies

Appendix B: Selected journals and their ratings according to different rankings

Journal	**Olson** (2005) max: 1.1	**VHB** (2011) max: A+	**CNRS** (2008) max: 1	**ABS** (2010) max: 4	**JCR** (2010)
American Journal of Disaster Medicine*					
Annals of Operations Research	2.97	B	2	2	0.675
Asian Journal of Social Science					0.053
Business Horizons		E		1	0.809
Computers & Industrial Engineering		C	3	2	1.543
Computers & Operations research	4.05	B	2	2	1.769
Decision Sciences	3.27	B	2	3	2.233
Development & Change			2		1.359
Disasters					1.174
European Journal of Operational Research	2.83	A	1	3	2.159
Expert Systems with Applications				3	1.924
Fuzzy Optimization & Decision Making					0.702
Harvard Business Review		D		4	1.881
IIE Solutions*					
Information Technologies & International Development*					
Interfaces	2.53	C		2	0.826
International Affairs					1.198
International Journal of Advanced Robotic Systems					0.326
International Journal of Educational Development					0.983
International Journal of Emergency Management*					
International Journal of Logistics Management		D	3	2	
International Journal of Logistics Systems & Management*					
International Journal of Logistics: Research & Applications		C	4	2	0.558
International Journal of Operations & Production Management	4.1	C	2	3	1.812
International Journal of Physical Distribution & Logistics Management		B	4	2	2.617
International Journal of Production Economics	4.06	B	1	3	1.988
International Journal of Productivity & Performance Management		D		1	
International Journal of Public Sector Management		C		2	
International Journal of Risk Assessment & Management*					
International Journal of Services Sciences*					
International Journal of Services Technology & Management		C			
International Journal of Strategic Property Management					2.615
International Studies Quarterly					1.523
International Transactions in Operational Research		D	3	2	
Journal of Business Ethics		C	3	3	1.125

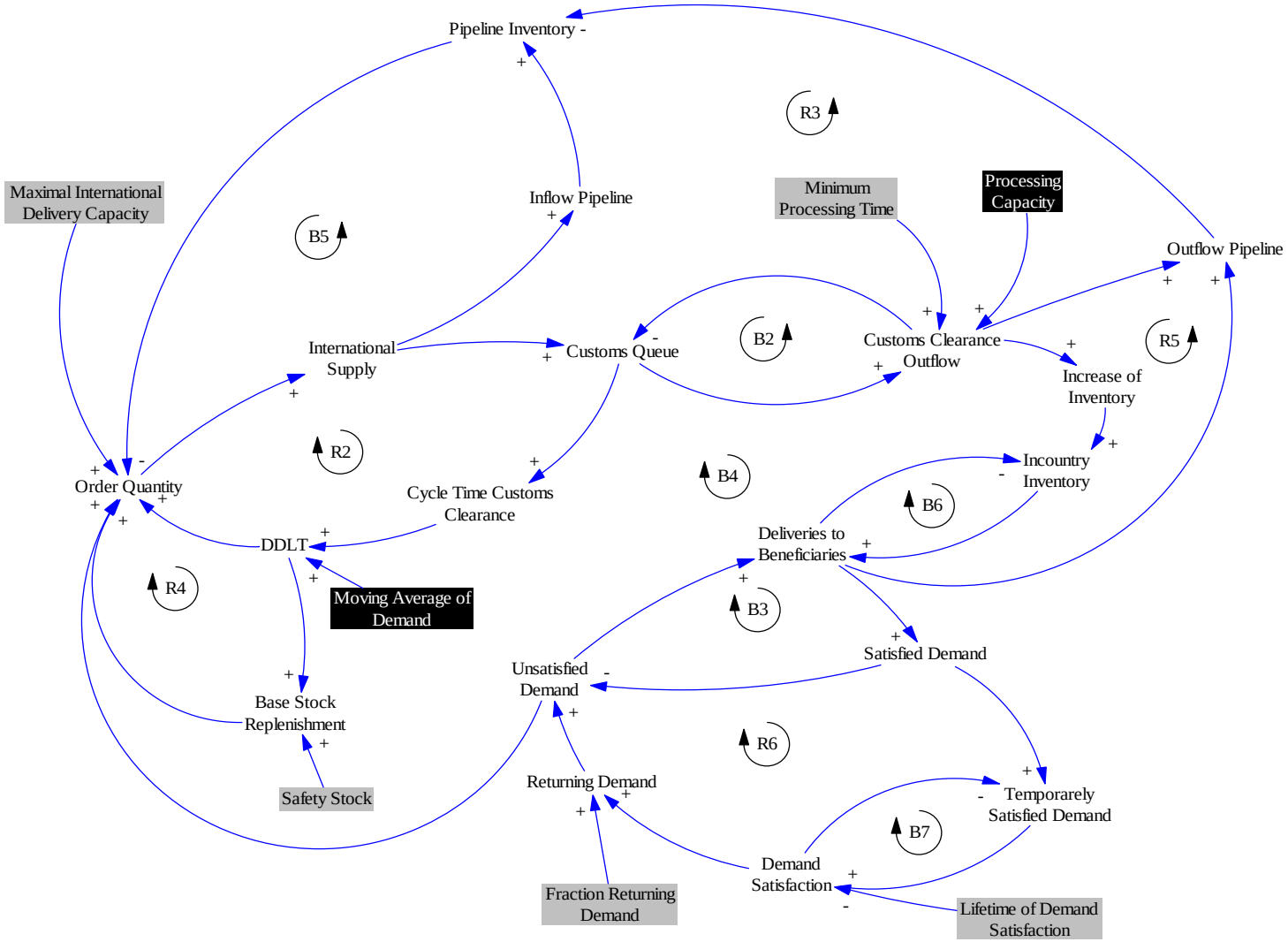
Journal	Olson (2005) max: 1.1	VHB (2011) max: A+	CNRS (2008) max: 1	ABS (2010) max: 4	JCR (2010)
Journal of Business Logistics	3.71	B		2	3.905
Journal of Global Optimization					1.16
Journal of Humanitarian Logistics & Supply Chain Management*					
Journal of Intelligent Transportation Systems					1.273
Journal of Manufacturing Technology Management			4	2	
Journal of Multi-Criteria Decision Analysis		B	4		
Journal of Network & Computer Applications					0.66
Journal of Operations Management	3.02	B	1	4	5.093
Journal of Public Procurement*					
Journal of the Association for Information Systems		B			2.217
Journal of the Operational Research Society	3.27	B	2	3	1.102
Journal of the Royal Statistical Society. Series C, Applied statistics			3	2	0.645
Knowledge & Information Systems					2.008
Management Accounting Quarterly		D	4		
Management Research News		C			
MIT Sloan Management Review		D		3	1.452
Naval Research Logistics	2.38	B	3	3	0.982
Operations Management Research		B			
OR Spectrum		A	3	3	2.03
Oxford Development Studies			3		
Papers in Regional Science			2		1.236
Production & Operations Management	2.99	A	1	3	1.851
Science		A+		1	31.377
Social Studies of Science					1.723
Supply Chain Forum: An International Journal		E			
Supply Chain Management: An International Journal		C	4	3	2.484
The Economic Journal					2.271
TOP: An Official Journal of the Spanish Society of Statistics & Operations Research			4		0.756
Transportation Research Part A: Policy & Practice		B	2	3	1.601
Transportation Research Part E: Logistics & Transportation Review		B	2	3	1.954
Transportation Research Record					0.482
Transportation Research, Part B		B	2	4	2.091
Transportation Science	2.42	A	2	3	1.514

*these relatively new journals were included in the selection even if not ranked

Appendix C: Types of problems experienced by relief organizations in different countries

Country	Organization A	Organization B	Organization C	Organization D	Average number of restrictions
Somalia			- Access barriers (organization) - Corruption		2
Sudan	- Import barriers (complexity)	- Import barriers (complexity) - Access barriers (visa)	- Import barriers (tariffs, delays, complexity and origin) - Control of activities - Access barriers (visa)	- Import barriers (complexity) - Corruption	2
DRC		- Import barriers (tariffs) - Corruption	- Import barriers (delays) - Access barriers (organization) - Corruption	- Import barriers (tariffs)	2
Myanmar		- Access barriers (visa) - Import barriers (delays and medicines restriction)	- Access barriers (organization and visa) - Import barriers (medicines restrictions) - Corruption - Bureaucracy	- Import barriers (complexity)	2.3
Chad	- Bureaucracy - Import barriers (tariffs, delays, complexity and satellite communication equipment restriction)	- Bureaucracy - Import barriers (complexity)	- Import barriers (tariffs)	- Corruption - Bureaucracy	1.8
Ethiopia			- Import barriers (delays, complexity, medicines restriction and satellite communication equipment restriction)	- Import barriers (delays, complexity, medicine restriction and satellite communication equipment restriction) - Bureaucracy - Access barriers (organization, visa)	2
Liberia				- Import barriers (medicines restriction) - Corruption	2
Cameroon	- Corruption - Import barriers (tariffs, complexity, delays and satellite communication equipment restriction)	- Corruption			1.5
North Korea		- Import barriers (delays, tariffs and complexity)	- Bureaucracy		1
Israel		- Import barriers (delays and satellite communication equipment restriction)			1
Georgia		- Import barriers (delays)			1
Bosnia	- Import barriers (tariffs, delays, complexity)				1
Libya (since 2011 crisis)		- Access barriers (organization) - Import barriers (satellite communication equipment restriction)	- Access barriers (visa) - Import barriers (satellite communication equipment restriction)		2

Appendix D: Feedback loops of System Dynamics main model *[gray boxes: constants, black boxes: link to sub-models]*



Appendix E: List of feedback loops of System Dynamics main model and sub-models

Customs Processing Capacity	
Balancing loops	
B1	Processing Capacity → Fractional Capacity Increase → Capacity Increase → Processing Capacity
Reinforcing loops	
R1	Processing Capacity → Capacity Increase → Processing Capacity
Main Model	
Balancing loops	
B2	Customs Clearance → Customs Clearance Outflow → Customs Clearance
B3	Unsatisfied Demand → Deliveries to Beneficiaries → Satisfied Demand → Unsatisfied Demand
B4	Unsatisfied Demand → Order Quantity → International Supply → Customs Clearance → Customs Clearance Outflow → Increase of Inventory → Incountry Inventory → Deliveries to Beneficiaries → Satisfied Demand → Unsatisfied Demand
B5	International Supply → Inflow pipeline → Pipeline Inventory → Order Quantity → International Supply
B6	Incountry Inventory → Deliveries to Beneficiaries → Incountry Inventory
B7	Demand Satisfaction → Temporarily Satisfied Demand → Demand Satisfaction
Reinforcing loops	
R2	Customs Clearance → Cycle Time Customs Clearance → DDLT* → Order Quantity → International Supply → Customs Clearance
R3	Customs Clearance → Customs Clearance Outflow → Outflow Pipeline → Pipeline Inventory → Order Quantity → International Supply → Customs Clearance
R4	Customs Clearance → Cycle Time Customs Clearance → DDLT* → Base Stock Replenishment → Order Quantity → International Supply → Customs Clearance
R5	Incountry Inventory → Deliveries to Beneficiaries → Outflow Pipeline → Pipeline Inventory → Order Quantity → International Supply → Customs Clearance → Customs Clearance Outflow → Increase of Inventory → Incountry Inventory
R6	Unsatisfied Demand → Deliveries to Beneficiaries → Satisfied Demand → Temporarily Satisfied Demand → Demand Satisfaction → Returning Demand → Unsatisfied Demand
Moving Average of Demand	
Balancing loops	
B9	Moving Average of Demand → DDLT* → Order Quantity → International Supply → Customs Clearance → Customs Clearance Outflow → Increase of Inventory → Incountry Inventory → Deliveries to Beneficiaries → Satisfied Demand → Unsatisfied Demand → Increase Cumulative Demand → Cumulative Demand → Moving Average of Demand

*DDLT: Demand During Lead Time