The Humanitarian Relief Supply Chain:
Analysis of the 2004 South East Asia Earthquake and Tsunami

by

Timothy Edward Russell

Bachelors of Science in Computer Science
Georgia Institute of Technology

Submitted to the Engineering Systems Division in Partial Fulfillment of the
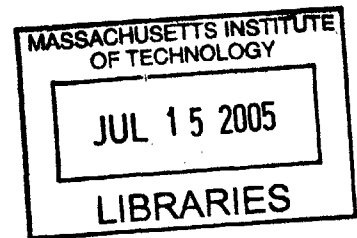Requirements for the Degree of

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Abstract

Humanitarian relief supply chains are not well documented. This thesis describes humanitarian relief supply chains in general and those specifically utilized in the 2004 South East Asia Earthquake and Tsunami relief effort. A survey, created in collaboration with the Fritz Institute and KPMG, informed the analysis and establishes baseline data for a sector with little formal measurement. It was found that relief organizations share common problems regardless of size, focus, or structure. While the survey determined that relief delivery was effective, the findings illuminated deficiencies in the following areas: initial assessment, collaboration, trained logistics experts, and supply chain analysis. Finally, the thesis suggests plans to address these issues and future research.

Thesis Supervisor: Jarrod Goentzel
Title: Executive Director, MIT-Zaragoza International Logistics Program

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Dedication

To Cambria. Thank you for your support.

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This thesis would not have been possible without many individuals: Jarrod Goentzel, for continuing to support this thesis from Spain; Mitsuko Mizushima and Kassia Echavarri-Queen of the Fritz Institute, for the opportunity to contribute to your work; the people of Gostivar, Macedonia and Saint Vincent and the Grenadines, for your generosity and introducing me to development; Bindiya Vakil, for taking the time to help me improve my writing; my fellow MLOG and HSI classmates, for your friendship.

Biographical Note

Timothy Russell completed a Bachelors of Science in Computer Science, areas of concentration Networking and Graphics, with a Psychology certificate in June of 1996. While there, he was named a Presidential Scholar. After college, he joined Lotus Development Corporation's application development efforts as a software engineer. In 1999, Tim left IBM / Lotus to join the US Peace Corps. He served for two years in the refugee-impacted city of Gostivar, Macedonia as a municipal development volunteer. After evacuation due to civil unrest, he served three years in Saint Vincent and the Grenadines as an information technology and adult education volunteer. In June of 2004, he left the US Peace Corps to attend MIT.

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1 Introduction

"Professional logistics assistance that is available on short notice is crucial to the success of rescue and relief operations and can save lives ... In major disasters, too often commodities are sent in from all over the world without consultation or coordination with rescue and relief teams on the ground."
— Adrian van der Knapp, Head, United Nations Joint Logistics Centre (Airport emergency team, 2004)

In 2003, over six billion dollars were spent on humanitarian assistance helping people around the world who were victims of emergencies and natural disasters. This was almost one dollar for every inhabitant on earth. This money provided food, shelter, and other humanitarian relief to people left injured, homeless, or hungry. The total amount of aid spent in 2005 will be significantly higher due to the Tsunami relief efforts. As of March 22, 2005, $6.4 billion dollars have been pledged for the Tsunami response alone.

Even before the Tsunami, the global picture on natural disasters was changing. The number of people affected by disasters, that is, events with negative consequences for humans, has risen at an alarming pace (Walter, 2003). During the 1990s, the number of people affected was nearly three times higher than during the 1970s. This is due to both population growth and the rise in the number of disasters.

The World Bank reports that the risk of death, destruction, and suffering has increased due to "accelerated changes in demographic and economic trends" (Kreimer & Munasinghe, 1991). Coastlines have become more populated and the value of property on the coast has risen. Disaster related costs rose from an average of $4 billion per year in the 1980s to $40 billion annually in the 1990s (Vellinga & Mills, 2001). The United Nations Environmental Programme

(UNEP) projects losses will top $150 billion per year in this decade. Jan Egeland, Under-Secretary-General for Humanitarian Affairs and Emergency Relief Coordinator, described the problem in the following way, "This tsunami is not the biggest in recorded history, but the effects may be the biggest ever because many more people live in exposed areas than ever before..."

These demographic and economic changes are taking place while the number of extreme weather events rises. Extreme weather events, whether or not they have had an impact on humans, have risen "about 50 percent on average each decade between 1900 and 1990, accelerating significantly since 1950" (Kreimer & Munasinghe, 1991). The Centre for Research on the Epidemiology of Disaster at Louvain University, Brussels, also described this phenomenon. Their data show a steady rise in the number of disasters from an average of 150 a year in 1980 to over 450 a year today. While the annual deaths from disaster (pre-Tsunami) fell by 30% in the previous two decades, the number of people affected by disaster has risen by 59% (Walker, 2005). More people are threatened by natural disasters than ever before, either by choice or through increased weather related incidents.

Threats from conflict and political violence have also been on the rise since the end of the Cold War. These conflicts compose a significant part of the humanitarian relief mission. The current conflicts in Afghanistan, Côte d'Ivoire, Darfur, Haiti, Iraq, and Sierra Leone demonstrate the impact of "complex emergencies."

The vast majority of those affected by emergencies and natural disasters live in developing countries. The poverty, crowded conditions, and environmental degradation experienced by these people make them the most vulnerable and least able to help themselves.

To save lives and alleviate suffering, the response to international emergencies must be timely, effective, appropriate, and well organized. This is where logistics can play a key role.

Logistics is central to humanitarian relief. The speed and efficacy of relief programs depends on the ability of logisticians to procure, transport, receive, and distribute supplies to the site of relief efforts. Thomas (2004) notes that logistics "serves as a bridge between disaster preparedness and response, between procurement and distribution, and between headquarters and the field." Time saved can bring needed supplies and personnel to desperate populations when they need it most. An effectively structured and managed relief supply chain can save lives. Money salvaged through efficient transportation can be reinvested in relief operations.

This thesis uses the 2004 South East Asia Earthquake and Tsunami as a backdrop to investigate the humanitarian relief supply chain. The next chapter provides background on disasters and emergencies, including the development of relief literature and the disaster management cycle. Chapter 3 outlines the use of technology in disaster response. The relief chain is introduced in Chapter 4. The methodology employed by this thesis is described in Chapter 5. Chapter 6 portrays the Tsunami and situations that arose during the relief effort. In Chapter 7, the results of a relief supply chain survey given to organizations providing Tsunami relief are analyzed and conclusions are drawn. This thesis concludes with recommendations for future research.

2 Disaster and Emergency Overview

Most disasters and emergencies have multiple causes and require complicated responses. The initial response may appear straightforward – supply water, food, shelter, and security. The end result of this humanitarian relief can have profound consequences. The aim of this chapter is to introduce the field of disaster and emergency response and reveal how it affects people.

2.1 What is a Disaster?

A crisis results in extensive human suffering, property damage, and a disruption of society. This stretches the community's coping mechanism beyond the breaking point. Crisis not only refers to an unexpected catastrophe, but also to the slow build-up of environmental, political, or economic factors that act on a society's vulnerabilities (Blaikie, 1994). The event becomes a disaster when the community's capacity to cope is overwhelmed and the status quo becomes untenable. The situation is then declared an emergency and assistance is requested. Disasters happen when hazards meet exposure due to vulnerability.

The term "natural disaster" is commonly used when describing the impact of a natural hazard on a community. They can be sudden-onset, such as floods, volcanoes, tsunamis, earthquakes, or hurricanes, or slow-onset, such as drought. The extent an individual or community is vulnerable determines the impact of the hazard.

The word "natural" implies that disasters are simply caused by nature. Current literature challenges this by commenting on the human causes for the damage caused by nature. Human systems create and reinforce factors that increase vulnerability to extreme stress. Inequity and poverty make people more vulnerable to the effects of hazards. Nature does not control the distribution of vulnerability. People choose to live in harm's way. Human triggered global warming is changing weather systems and increasing the frequency and intensity of storms. While nature is at work here, the root cause is often human.

Like natural disasters, hazards of a human origin can be sudden-onset, such as industrial accidents, war, or civil unrest, or slow-onset, such as low-level conflicts or systematic discrimination against specific social groups. The term "complex humanitarian emergency" is used to describe situations when political or military actions exacerbate hazards or cause a disaster. A complex emergency often involves a large, rapid displacement of people. This may be due to violence stemming from ethnic cleansing or genocide. In a complex emergency, relief assistance can become entangled in the politics of the situation. Darfur and the Tsunami response in rebel held areas of Indonesia and Sri Lanka are recent examples of complex emergencies.

Recently NGOs, such as Oxfam, have rejected the traditional dichotomy between emergency relief and development. They have abandoned the view that emergencies are temporary interruptions in the continual process of development. Their new perspective is that these crises are often the result of the chronic unstable situation of countries and their inhabitants. This view changes the role of organizations offering humanitarian assistance. They move away from a provider of supplies towards an agency ensuring that their humanitarian relief efforts systematically address the root causes of crisis.

2.2 Sociology and Disasters

Regular research on disaster emerged after World War II. This effort was pioneered, between 1949 and 1954, by a research project at the National Opinion Research Center at the University of Chicago, which became the paradigm of quick response field studies made before, during, and after disasters (Drabek & McEntire, 2003). Much of this research was guided by ideas of collective behavior.

With the establishment of the Disaster Research Center (DRC) in 1963, the collective behavior framework merged with a focus on community and organizational changes during disasters. The DRC's research used sociological concepts to analyze and describe community and organizational behavior in disasters (Dynes & Tierney, 1994).

In 1975, geographer Gilbert White and sociologist Eugene Hass published the first national assessment of natural hazards (White & Haas, 1975). Until that point, there was little work exploring the economic, social, and political aspects of adjustment to natural hazards. Their observations and criticism have had considerable impact on hazards research over the past thirty years.

Over time, the literature on disaster transitioned between two different perspectives. The first is the functionalist perspective, which considers disaster events that are then followed by social consequences. The second perspective, focused on vulnerability and how it is created, views the causes of disaster as internal to the social order. Hence, societies of today produce the disasters of the future.

In 1961, Charles Fritz defined the functionalist perspective. "Actual or threatened accidental or uncontrollable events that are concentrated in time and space, in which a society, or a relatively self-sufficient subdivision of society undergoes severe danger, and incurs such losses

to its members and physical appurtenances that the social structure is disrupted and the fulfillment of all or some of the essential functions of the society, or its subdivision, is prevented." He describes societies as systems organized about essential social functions. Disasters originate in the environment and impinge on social systems. When a disaster occurs, it forces these systems to adapt. This perspective is rooted in functionalist assumptions such as no conflict, no diversity, and that problems originate outside the system. This perspective is also event focused, rather than process focused. In fact, it characterizes disasters as beginning at the time of impact.

The second viewpoint does not view disasters as singular events. The vulnerability perspective approaches disasters in sociological terms and as fundamentally social events. This view, best described in Disasters By Design (Mileti, 1999), looks toward society for the problems and the processes that lead to disaster. Thus, disasters and their impacts are socially produced. This framework assumes that society is not an integrated system, but characterized by inequality and potential for conflict. Societal factors and processes create differentially vulnerable groups. This leads different social units to experience disasters differently.

Building on the vulnerability perspective, David Alexander (2000) identifies several additional lenses through which disaster can be viewed. Economically, disaster results in the accelerated consumption of goods and services. Socially, disaster is seen as a phenomenon that stresses human organization and tests human adaptability. Physically, disaster can be considered extremely destructive events. Sociologically, disaster can be a window into society that allows one to observe the social and cultural processes under extreme duress that exposes their inner essence. Disaster provides opportunities to improve mitigation because they galvanize public and political opinion to demand improved safety.

2.3 Disaster Management Cycle

A disaster is defined as a serious disruption of the functioning of society, causing

widespread human, material, or environmental losses that exceed the ability of affected society

to cope using only its own resources (UNDHA, 1992). Disasters are often classified according

to their cause, natural or manmade. Hass was among the first to describe disasters as a process

or cycle (Hass, Robert, Martyn, & Amaral, 1977). He developed a model of urban recovery

(Figure 1). Hass divided the process of recovery into four stages: emergency, restoration,

reconstruction, and major reconstruction. Recovery progresses from one stage to the next. The

time scale is logarithmic with each phase lasting about ten times longer than the previous phase.

This model assumes that disasters and the recovery process are ordered and knowable. This is

very different from the current theories of disaster management.

Periods:	Emergency	Restoration	Reconstruction I	Reconstruction II
Capital Stock:	Damaged or Destroyed	Patched	Rebuilt (Replacement)	Major Construction (Commemoration, Betterment, Development)
Normal Activities:	Ceased or Changed	Return and Function	Return at Predisaster Levels or Greater	Improved and Developed
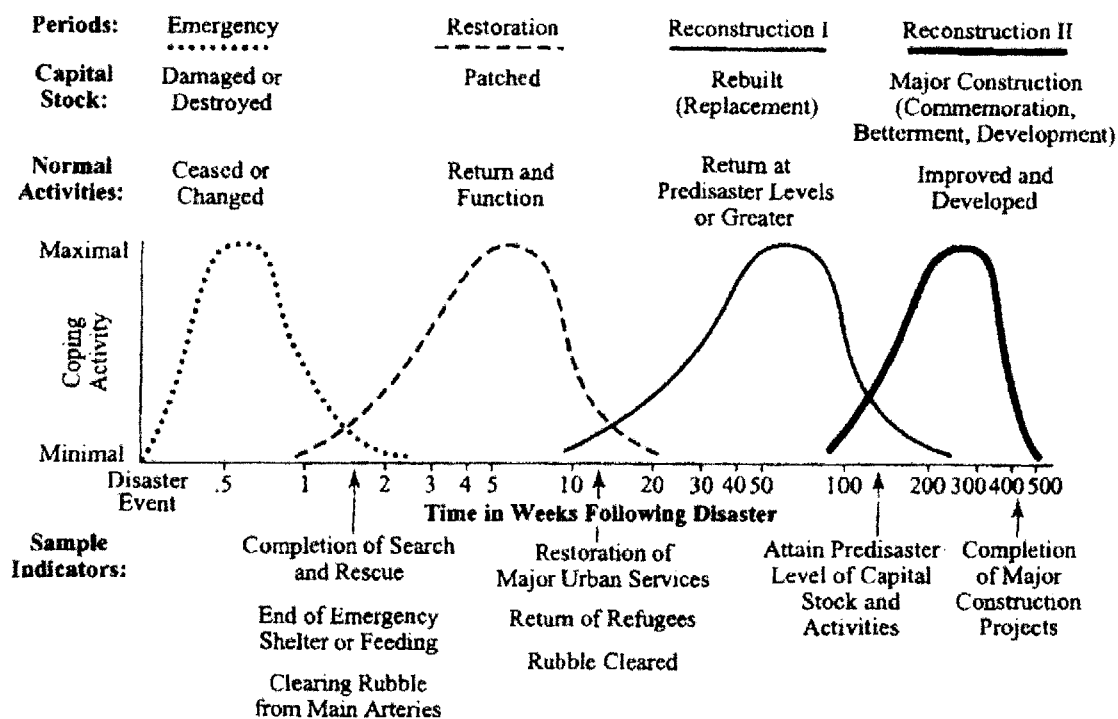
Figure 1 Model of Urban Recovery (Vale & Thomas, 2005)

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Currently the field of disaster management is described with varying terminology and in different forms. An important feature of the field is that the management of disasters is viewed as a continuous process that does not begin and end with each disaster event. This sets it apart from Hass' model of urban recovery. The phases of disaster management include preparedness, impact, response, recovery, development, and mitigation (Carter, 1991). This does not mean that activities during a disaster are divided from each other and separated in time. Often they overlap. In fact, Oxfam is leading the current trend to combine response with recovery and development activities.
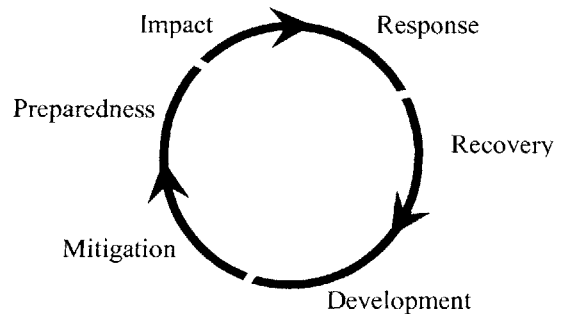
Figure 2 Disaster Management Cycle

When viewing the humanitarian supply chain through this lens it is important to note two factors. First, the humanitarian supply chain must be planned and not cobbled together at the start of an emergency. Second, as relief activities move from the response phase to recovery and development, the supply chain moves away from a "push" strategy, where aid is supplied without waiting for demand to be accurately determined, toward a "pull" strategy, where need determines the quantity of aid being shipped. In Figure 3, Beamon (2004), building on Thomas (2002), develops the life cycle of a relief mission.
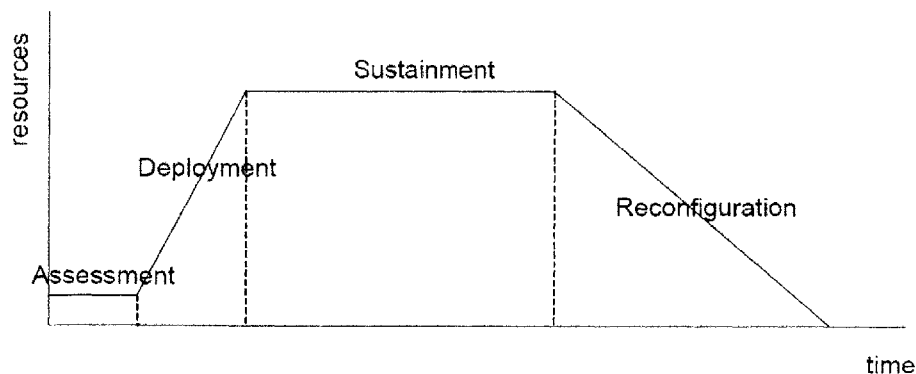
Figure 3 Relief Mission Life Cycle (Beamon, 2004)

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It begins with an assessment that lays the groundwork for the development of the relief supply chain. Next, during the start of the relief phase the relief supply chain is deployed. Supplies are pushed into the affected region and a structure is created that can be sustained. As time progresses and the immediate needs of food, water, and shelter are met, the relief supply chain's method of operation changes. Supplies are now delivered on a schedule or by request as opposed to on an emergency basis. Operations begin to slow and the supply chain is either shut down or handed off to a local organization.

2.4 How Development Shapes Response

When disaster strikes, development is retarded. A disaster can be managed by prevention and effective response. The development of a community both shapes and influences the impact of disasters and the response to them. Unsuitable development, such as structures ignoring earthquake building codes or coastal development in eroding areas, increases vulnerability to disasters. The ability to deal with disaster is a gauge of the level of development.

For example, different countries experienced the impact of the Tsunami in different ways. For the most part, Malaysia, Thailand, and India refused outside assistance following the Tsunami. Their level of development enabled them to offer assistance to other countries. Indonesia, Sri Lanka, and the Maldives were not in the position to help.

Chronic complex emergencies, in places such as Somalia, Sudan, and Angola, move from one crisis to another. Humanitarian aid in such situations must be more than just food, water, and shelter. It should involve programs that work to resolve the underlying problems and build livelihoods for those displaced by the fighting. Relief work is often under intense pressure. It is easy to rush to provide assistance and not focus on the social and cultural aspects of those

affected by the emergency. Doing so only saves lives in the short-term without approaching a solution.

In all of this, a disaster may provide an opportunity for change. Response measures are taken immediately following a disaster. Properly designed relief programs can ameliorate a crisis and reduce the vulnerability to future disasters. Improperly designed relief programs can aggravate a crisis and impede recovery. These measures are usually directed towards saving life and dealing with the immediate damage. In responding to disasters, organizations should also lay the foundation for long-term development. When recovering from a disaster, the hope of a better future must be nurtured.

2.5 *People in Disasters*

A disaster clearly has a major impact on people's lives. Disasters are invasive and becoming more frequent aspects of life (Walker, 2005). They are the outcomes of human settlement patterns, land use decisions, and the use of risky technologies. In other words, disasters are primarily social events that affect groups. Some groups feel the effects more than others do. The group's relationships will influence their vulnerability and ability to cope.

Disasters affect how groups are able to cope with their vulnerabilities. The people most affected by a disaster are the direct victims – the sick, injured, or those who suffered the loss of someone or the loss of property. The other members of the community will experience difficulties as well. Economic and political systems are weakened by emergencies. For example, some Indonesian schools were not able to reopen due to the lack of teachers. The relief workers, both local and international, also experience change in their lives.

When a community is disrupted, family and community structures and local and state politics are affected. These changes can impact the vulnerability of people in different ways.

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Disasters, however natural, are discriminatory. When they strike, pre-existing social structures determine who will be less affected and who will pay a higher price.

There is also a cultural filter through which individuals, families, peer groups, communities, and societies perceive disaster (Alexander, 2000). Populations within disaster-affected areas experience and perceive a range of social effects. Individuals may be traumatized by their experience. Families may be separated by the event have difficulty locating each other.

An often-overlooked aspect of disasters is that there are 'winners' as well as 'losers'. Some groups or individuals may benefit as a result of increased demand for their goods and services after a disaster. On the other hand, survival needs may force other groups or individuals to borrow money. This commonly pushes families into heavy debt. A series of disasters in an area may adversely affect the same set of households to the point of destitution.

Income, ethnicity, age, and gender are among several dimensions that determine how people are affected by disasters (Oxfam, 2005; OECD, 1994). Looking closer at gender, if a household becomes indigent, women are more likely to be victimized by men or forced to enter into prostitution for income. The sick or injured from a disaster are usually the responsibility of the females in the household. This added workload has implications for the education of the daughters and the nutrition of the family. More work translates into less time to fetch water or grow food.

2.6 Potential Problems with International Assistance

Relief is an outside intervention and how it is administered can either assist or handicap a society (Long & Wood, 1995). Large amounts of international aid flooding into a region can wreak havoc. The rapid introduction of aid can disrupt local economies, develop dependence,

and create surpluses. In Ethiopia, aid groups brought in cooking-oil as part of a food program. This oil directly competed with local producers and drove them out of business (McLaughlin, 2004). These effects can be ameliorated in the long run, but in the short-term they impose an added hardship on individuals as they struggle to re-establish former markets.

In countries facing chronic crisis, a dependence on aid can develop. As communities and individuals come to expect international relief, they lose traditions of self-reliance and depend on aid. National governments can fall into this pattern as well and fail to fund adequate disaster prevention in the belief that the international community will come to the rescue.

Generous donations and swarms of organizations can overwhelm a disaster site. Often aid is sent with no regard for its suitability or the amount of aid that has already been received. After a hurricane, fruit was shipped to Central America. On arrival, the fruit had to be destroyed because of the danger of introducing foreign pests to local crops. Chapter 7 further discusses the deleterious effects of unsolicited aid.

2.7 The Field of Logistics and Disasters

The term logistics is used in two fundamentally different forms. One optimizes physical, informational, and financial flows, through a network. The other coordinates a sequence of resources to carry out some project. This thesis is concerned with the first usage. Originally, logistics applied to military procedures for the transportation and re-supply of materials and personnel. Logistics now has practical applications in business and humanitarian relief endeavors.

2.7.1 Military Logistics

The military continues to provide humanitarian assistance along side Non Governmental Organizations (NGOs). The humanitarian sector has strengths in procurement, medical assistance, interaction with local communities, water and sanitation, and dealing with displaced populations. Due to its well-defined command structure and size, the military has the ability to respond faster to large-scale emergencies than humanitarian organizations (OECD, 1998). NGOs' credibility and identity rests on their ability to act independently, or rather their ability to be perceived as acting independently from governments and their militaries. Given NGOs' need to preserve independence, efforts have been made to create a coordination structure, a Civil Military Operations Center (CMOC), which exists between the military and civilian organizations. CMOCs not only help with coordination, but also allow NGOs to maintain autonomy (Seiple, 1996). This model was effectively put to use in Goma, Zaire and Entebbe, Uganda in 1994 when the United Nations (UN) prioritized needs and accessed the military logistics command center through the CMOC. There was no need for contact between NGOs and the U.S. military.

The military is investigating technology that could be useful to the humanitarian supply chain. The military is experimenting with modeling concepts, novel organizational structures, commercial off the shelf solutions, and advanced concept technology demonstrations. Stytz and Banks (2002) discussed the incorporation of delivery, supplies request, and transportation of necessary supplies into computer-generated force modeling and simulation. Logistical constraints can cause decisions to ripple through every other operation currently underway. Until detailed logistics considerations are included in force models, accurate information cannot be obtained.

Cahlink (2004) determined how to get troops, equipment, and supplies to the Persian

Gulf faster and more efficiently. Working with the military's top logisticians, he started by

reorganizing Transportation Command (TRANSCOM) so that it oversees all of the logistical

operations. The Defense Department also began work on a new logistics information system,

sense-and-respond.

An automated sense-and-respond logistics system is envisioned which relies on

battlefield sensors, satellite networks, and computer databases to determine when supplies are

running low, which facilities should replenish them, and when and how they should be delivered.

The system is networked allowing data to flow from the battlefield to supply units and

contractors enabling requirements to be filled as they emerge (Hughes, 2004). This same

technology identifies supply usage patterns earlier than is currently possible. The military

expects to benefit from improved real-time performance of logistics for network-centric

operations, a reduced logistics footprint, enhanced efficiency, and lower costs.

2.7.2 Business Logistics

Amidst a wealth of literature covering business and the supply chain, the segment of that

literature that includes disasters and relief work relates to continuity management and the

vulnerability of supply chains. The Council of Logistics Management published a whitepaper on

the supply chain continuity management process in 2002 (Helferich & Cook, 2002). The paper

described a process consisting of five stages: planning, mitigation, detection, response, recovery.

The authors argued for the need to have command, control, and review lessons learned at each

stage.

After the attack on the World Trade Center on 9/11, the research focused more on supply

chain vulnerability to terrorist attacks. Sheffi (2002) wrote about disasters and supply chains

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through the lens of terrorism. He called for companies to redesign their supply chains with security in mind, use proven methods to deal with uncertain situations, and for greater public – private partnerships. Sheffi argued that corporations, with their expertise, could help public response efforts in the logistics arena. He pointed to work done by the World Economic Forum to create the Disaster Resource Network (DRN) as steps in the right direction. The work of the DRN during the Tsunami response will be discussed in Chapter 9. Samii, Van Wassenhove, and Bhattacharya (2002) also called for greater collaboration between private companies and nonprofit organizations.

2.7.3 Relief Logistics

Relief operations have the same needs for coordination, collaboration, visibility, and logistical information systems as the military and business sectors. They are often high stakes life-and-death operations. They often occur away from major traffic lanes in less developed regions with inadequate infrastructure (Long & Wood, 1995). Locations are frequently unknown until the demand occurs. Short lead times dramatically affect inventory availability, procurement, and distribution. Transportation and supply information is unreliable, incomplete, or non-existent. Due to the high stakes nature of disasters and complex emergencies, the desire to rush aid to victims, and the lack of coordination of NGOs, many relief operations are ad hoc and poorly structured.

Recent work has begun to explore the correlation between relief supply chains and both military and business supply chains. Beamon (2004) compared and contrasted the commercial supply chain and the humanitarian relief chain and discussed the challenges faced by relief chain logisticians in practice and research. The World Food Programme (WFP) is working with the logistics company TPG (Royal TPG Post, the national postal operator in the Netherlands active

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worldwide) to bring business insights into the world of humanitarian assistance. By offering services to enhance WFP's existing logistics, TPG reduced operating and delivery costs enabling WFP to feed more people (Shister, 2004). They also designed a pre-positioning depot in Brindisi, Italy saving, WFP millions of dollars.

Commercial supply chain research and analysis demonstrate potential improvements from strategic inter-corporation collaboration. The Interdisciplinary Program in Humanitarian Relief at the University of Washington has been working in conjunction with the Fritz Institute to determine the applicability of these commercial methods to humanitarian operations (UW-IPHR, 2004).

Other research has focused on measurement of supply chains that function in disasters and complex emergencies. Thomas (2002) described a method to quantify the reliability of supply chains. Using reliability interference theory, he measured reliability in contingency operations, such as national disasters, that require immediate responsive operations. During the Humanitarian Logistics Conference of 2003, Maria Rey, of The Georgia Institute of Technology, spoke about web-based benchmarking and humanitarian logistics metrics. She argued that the establishment of key performance measures enables the alignment of organization's strategic objectives to its logistics strategy. Rey suggests benchmarking to highlight areas that need more attention and determine if there are leaders in the humanitarian sector.

Organizations provide relief for different reasons (Long & Wood, 1995). Governments provide relief as a proxy for diplomacy and surplus grain distribution. NGOs are motivated by humanitarian concerns. Different motivations can produce different kinds of relief chains. Americares specializes in time sensitive relief. It does not take the time to assess the needs of the beneficiaries of its aid. Instead, it fills a plane full of supplies and flies it to the crisis area as

fast as possible. The United States Agency for International Development (USAID) and its Office of US Foreign Disaster Assistance (OFDA) take the opposite approach. It does not act without first performing a needs assessment and determining what and how much to supply a relief operation.

Unless coordination, communications, and information systems are employed in emergencies, these diverse motivations can lead to chaos and wasteful actions. In fact, every humanitarian operation could benefit from better these strategies. They are each explored in more detail in Chapters 4 and 5.

3   Disasters and Technology

"If the automobile and airplane business had developed like the computer business, a
Rolls Royce would cost $2.75 and would run for 3 million miles on one gallon of gas. And a
Boeing 767 would cost just $500 and would circle the globe in 20 minutes on five gallons of gas."
— Tom Forester, The Information Technology Revolution

The dramatic reduction in price of computers and their increasing speed and portability

led to the revolution in electronics, computing, and telecommunications. This revolution has

transformed how we live, work, communicate, and learn (Gates, 1995). Stephenson and

Anderson (1997) traced the changes this revolution has produced in disaster response. This

chapter characterizes that discussion and describes the current state of communication, logistics,

and humanitarian information systems.

3.1   The Eighties – Access

Microprocessors substantially changed the cost of computing in the early 1980s. Usable

desktop computers were suddenly within reach of businesses and individuals. Rudimentary

software became available allowing word processing, database management, and numerical

analysis. Diskettes made data portable.

The impact of microprocessors on disaster efforts was at first limited by the cost of

storage and inadequacy of early databases. Federal institutions and corporations, such as FEMA

and Union Carbide, created in-house solutions. These applications were poorly documented,

relied on printed spreadsheets to transmit results, and were not portable.

Even with these limitations, computers were used for administrative tasks. They allowed

field offices the ability to produce their own documents and run interactive calculations.

Spreadsheets could calculate food requirements. Databases could track beneficiaries. Project

management became much easier and independent from the main office. MIT's Center for

Transportation Studies developed one of the first evacuation software packages. NETVAC was

a dynamic network model for the evacuation of nuclear power plants (Sheffi, Mahmassani, &

Powell, 1980). EIS (Emergency Information Systems) International Corporation recognized the

need to prepare for and communicate during disasters and created the first commercial attempt to

use computers in real-time emergency information management. Geographic Information

Systems (GIS), such as SPLASH and SLOSH (Griffith, 1986), were also beginning to be

developed to map disaster risks (Marston, 1986). These systems utilize computer generated

maps as an interface for integrating and accessing massive amounts of location based

information.

Radio communications also advanced during the 1980s. Amateur radio operators have

provided emergency communications during disasters since 1910 (Coile, 1997). The 1980s saw

the Federal Emergency Management Agency (FEMA) sign an agreement with the American

Radio Relay League (ARRL) coordinating their resources so that volunteers could support

emergency communications. Digital radio communications developed during this time.

Amateur radio operators set up a wireless digital packet network before the internet became

widespread. Today boaters still use digital radio packet networks to send and receive e-mails

while at sea. In 1983, the Radio Amateur Satellite Corporation (AMSAT) worked with VITA to

combine packet radio and low-orbiting satellites to reach isolated areas in Africa (Garriott,

1991). Communication systems such as these are critical when managing relief operations, especially in an emergency.

3.2 The Nineties – Software and Communications

The start of the 1990s witnessed a continuation of the trends from the 1980s. Equipment became smaller and more portable, processing power increased, and bandwidth increased. Information became more readily available in databases and on CD-ROM. By 1990, laptops and portable printers could be carried on a disaster response.

These equipment advances led to the creation of commercial software. EIS continued the development of its resource and incident tracking databases. SoftRisk also entered the crisis management software space. GIS systems left expensive workstations with the introduction of software packages such as ARC-Info, MapInfo, and Intergraph. Logistics software was also developed during this period. The World Food Programme (WFP) created the Food Aid Information System. The PanAmerican Health Organization (PAHO) created SUMA to track medical supplies in emergencies (De Ville de Goyet, 1993).

However, communication innovations had a much stronger impact on humanitarian efforts. The fax machine was the first innovation on the scene. Quick, easy, cheap, and reliable, the fax was an instantly popular means of document transfer. During this same time, telecommunication companies were switching from voice networks to packet switching networks allowing the efficient transfer of data. Commercial e-mail services such as CompuServe became available. Electronic bulletin boards became popular places to share information. Emergency management professionals established several, such as the Emergency Preparedness Information Exchange (EPIX). This electronic communication allowed remote access to information and broke down the barriers to information exchange.

Later in the 1990s, computers became faster and cheaper, software became easier to learn and more robust, networks proliferated, and e-mail use became commonplace. During this time, e-mail list servers developed as a primary source of information and communication. DHA (now known as OCHA) list servers delivered situation reports to interested parties during the conflict in the Balkans.

This set the stage for the emergence of the World Wide Web (WWW) and the Internet. Supported by open standards (HTTP) and free browser software (Mosaic), the WWW doubled in size every few months. It is hard to imagine the world before the Internet. Information is readily available to anyone with a connection. Research is fast and much more comprehensive given improvements in access to literature. As soon as disaster bulletins and situation reports are written, they are available on the Internet almost immediately.

3.3 Current State – Communications, Community, and Software

Recent work has seen progress in communications and in communities created to enhance communication. Advances in wireless communication include new standards and widespread use in the field. For example, GIS provides critical information to relief agency staff about how humanitarian support efforts are progressing and helps ensure agencies are acting in a coordinated and efficient manner. Once in the field, the coordination continues as new data are added and distributed through wireless applications and Internet connectivity. The widespread availability of the Internet has also encouraged the creation of networks of relief workers.

3.3.1 Communications

During a disaster, communication is as important as food and water. A disaster can damage telecommunication infrastructure. If an event happens in a densely populated area,

thousands of people can try to make calls at the same time overloading the system. NGOs

recognize the importance of communication. Those with sufficient resources have developed

internal communication solutions. For example, the American Red Cross, through its Disaster

Services Technology Integration Project, has created mobile communication trucks. The

telecom trucks, once positioned, provide "48 phone lines, high-speed internet access, e-mail and

satellite-enabled communication with national headquarters" (Larkin, 2001). These trucks were

deployed during the response to the 9/11 attacks and during Hurricane Lili in 2002. The ability

to have real time information on victims, volunteers, logistics, and financial information allows

the American Red Cross to respond in an efficiently coordinated manner (Rudduck, 2002).

     Organizations operating in more remote locations or on smaller budgets must rely on

other options. Table 1 is a list of currently available communication options.

Short Wave or HF Radio	High Frequency (HF) radio allows voice communication over medium to long range. It can connect to mobile phones and the international telephone network. Peripheral units connect with the international network via fixed short-wave radio stations. These systems can call other stations, link with Global Positioning Systems, provide FTP like data transfer, e-mail using true TCP/IP, and fax between stations. It is also possible to set up local radio-to-telephone links that in the medium to long term are cheaper to run than using the ground stations. Short-ware systems do require experienced installation and operation, antennas, and significant electric current - normally a local main, generator, or battery power supply.
VHF Radio	Very High Frequency (VHF) is a short-range system for "line of sight" links, suitable for voice communication between mobile or hand-portable transceivers over limited distances, and between mobiles and permanent sites. There is no access to international telecommunications networks. Setting up and operating a VHF system does not require prior knowledge. The transmitters use little power and can be operated from a vehicle battery.

Cellular Phones	Cellular phones are increasing prevalent the world over. If a disaster happens in an area with cell infrastructure, but does not damage it, cell phones can be the most cost effective means of communication. If an event damages cellular towers, temporary towers can be erected. They can also be placed in refugee camps. During the tsunami, Nortel installed a system such as this to enable cellular communications in a ten-mile radius of Banda Aceh.
Satellite communications	The InMarSat constellation of four geostationary satellites is used to provide high-quality direct-dial voice, fax, and telex communications to and from the international public telecommunications networks. Mobile-to-mobile calls may also be made; but as this involves two satellite 'hops', the quality will be reduced and the charges will be higher. Recently, InMarSat has offered a service called Regional Broadband Global Area Network, or RBGAN. This is a satellite terminal allowing internet access. Iridium uses a constellation of 66 satellites in a near polar Low Earth Orbit (LEO) with cross-link architecture. Iridium services include worldwide voice, paging, Short Message Service (SMS), and data communications using lightweight, handheld phones and paging devices.

Table 1 The most practical communication options (Cutts & Dingle, 1998)

3.3.2 Community Building

There is a body of research addressing coordination and the use of information technology. Malone and Crowston (1994) first described coordination as the process of managing dependencies between activities through information technology and cooperative work tools. Often, in the time immediately following a disaster, information is fragmented and is hard to interpret (OECD, 2004). In an effort to piece together disparate aspects of disaster relief, many applications and websites have been developed. These programs use information technology for sharing resources and transferring knowledge. Situation reports, reports on damage to infrastructure and critical systems, information about hazards, weather reports,

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casualty reports, interagency coordination information, and requests for assistance or resources are all shared as part of these information systems (Alexander, 2002).

The growth of the Internet has transformed this kind of collaboration and coordination into community building. An online community is the concept of bringing people together in a virtual space. It includes a variety of activities such as electronic collaboration, web-based discussions, e-mail lists, electronic libraries, distance learning, and web-inars. The Internet alleviates some of the difficulties in sharing learning and lessons, in accessing timely information, and in reducing duplication of efforts and humanitarian relief organizations have made a large effort in this area. Several of the bigger relief communities are discussed below.

Relief Web (http://www.reliefweb.int) was launched in October 1996 and is administered by the UN Office for the Coordination of Humanitarian Affairs (OCHA). Relief Web is the world's leading on-line gateway to information for UN departments and agencies, NGOs, governments, donors, journalists and the public on complex humanitarian emergencies and disasters worldwide. It provides timely, reliable, and relevant information as events unfold, assisting the international humanitarian community in effective delivery of relief, preparedness, and prevention activities (About ReliefWeb, 2005).

AlertNet (http://www.alertnet.org) was launched by Reuters Foundation in 1997 to provide global news, communications, and logistics services to the international disaster relief community and the public. It delivers fast and reliable information to more than 300 member emergency relief organizations from over 80 countries so that they can respond quickly and efficiently to disasters. Anyone can access the public pages, which carry a news feed together with articles about the latest humanitarian crises. Membership allows exchange of professional information in a members-only password-protected zone and access to additional reference

material and a more extensive news feed. The online service also includes the following: an international register of aid suppliers, databases of jobs, training, events, and contacts in the disaster relief community, plus relevant background information (*Reuters AlertNet - About us*, 2004).

The United Nations Joint Logistics Center (UNJLC - http://www.unjlc.org) is an inter-agency group that co-ordinates and optimizes the logistics capabilities of responding humanitarian organizations. UNJLC is funded from voluntary contributions channeled through WFP (UNJLC, n.d.).

The Integrated Regional Information Networks (IRIN - http://www.irinnews.org) operates in sub-Saharan Africa and Central Asia. Its reporting focuses on strengthening universal access to timely, strategic, and non-partisan information to enhance the capacity of the humanitarian community to understand, respond to, and avert emergencies *(United Nations – OCHA IRIN - About*, 2005). IRIN further supports efforts at conflict resolution and reconciliation by countering misinformation and propaganda. The Southern Africa Humanitarian Information Network (SAHIMS - http://www.sahims.net) also aims to improve the knowledge base of humanitarian operations in the region by facilitating data sharing and networking existing partners.

Aid Workers Network (http://www.aidworkers.net/) links relief and development field staff, enabling them to share support, ideas, and best practice. This web site aims to provide a comprehensive resource for busy field workers needing practical advice and proven resources to help with their current work.

Information systems also play a key role in disaster mitigation. The World Food Programme (WFP) and its early warning system, Vulnerability Analysis and Mapping (VAM -

http://vam.wfp.org), supports the design, and assessment of WFP's emergency and development activities. USAID's Famine Early Warning System Network (FEWS-NET) also plays a similar role. The goal of FEWS NET (http://www.fews.net) is to strengthen the abilities of African countries and regional organizations to manage food insecurity through early warning and vulnerability information. FEWS NET is funded by USAID. The Humanitarian Early Warning Service (HEWSweb - http://www.hewsweb.org) is a broader inter-agency partnership aimed at establishing a common platform for humanitarian early warnings and forecasts for natural hazards and socio-political developments worldwide. HEWSweb brings together and makes accessible global early warning information from multiple institutions (*Early Warning Web Service, about us*, n.d.).

Finally, Global Hand and the Logistician's Network are two smaller sites that try to solve logistical issues. Global Hand (http://www.globalhand.org) is a network which aims to help everyone in the gifts-in-kind arena find one another. Global Hand's goal is to be a one-stop-shop for all parties involved in the movement of goods needed for humanitarian purposes. Logisticians' Network (http://www.aidworkers.net/logistics) is a community of practice for field logisticians in relief and development organizations seeks to record lessons learned, offer advice, and provide examples of paperwork to save time for other logisticians.

The UN has attempted to provide alternate means for organizations to collaborate and coordinate. In 2001, OCHA commissioned a report to review physical information centers located within a country with a humanitarian need centers and investigate how to support the creation of new information centers (Currion, 2001). The authors reported that information centers are more suited to coherent and compact geographical regions, rather than large and

shifting environments. Tight geographical regions allow NGOs to come to one place to obtain and share information.

3.3.3 Logistics Software Used in Disaster Relief

Relief logisticians must procure and track supplies from appeal to delivery while observing financial information and the movement of goods along the relief pipeline. The availability of accurate and pertinent information is crucial. Despite their role in providing relief to beneficiaries, logisticians are rarely incorporated in the purchase and development of information technology solutions relating to relief operations (Lee & Zbinden, 2003).

Many organizations have been providing relief for decades. As the information technology revolution overtook them, they developed ad-hoc systems to help manage the logistics of disaster relief. Yet, most relief activities are coordinated using only Microsoft Excel. Because there are few technical systems experts on staff and focus on overhead reduction, software development has been left by the wayside. Consequently, these systems are short on historical data, poorly connected, lacking integration across functions, error prone, poor at reporting, and not able to handle food, non-food, and gifts-in-kind all in one system.

Recently the Fritz Institute, along with help from researchers at the University of Washington, investigated this problem. First, they performed an analysis of the logistic systems in use by leading NGOs. Table 2 provides a quick overview of some of the systems currently in place below. Afterwards, they teamed with the International Federation of the Red Cross (IFRC) to develop Humanitarian Logistics Software (HLS) aimed at addressing many of deficiencies present in the current logistics systems.

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System	Strengths	Weaknesses
SUMA (PAHO)	• Independent versions – Central, Pledges, and Stock – for individual needs • Elaborate process coverage	• Planning • Inter-modular and inter-version workflow
Microsoft – FACTS (Save the Children / Mercy Corps)	• Project / program orientation • Good process coverage • Suitable for food items, supports ration definition	• Logistics management • Workflow integration
Commodity Tracking Systems CTS2000 (World Vision)	• Numerous reports • Good process coverage • Context sensitivity help at screen level	• Logistics management • Workflow
CTS (Save the Children)	• Simplicity	• Planning • Procurement • Reporting needs • Logistics management • Insufficient business process coverage
Purchase Plus PALMAS (Oxfam/IRC)	• Request for Quote (RFQ) and bid registering • Bill of Material and kitting • Fixed assets	• Planning • Logistics and tracking • Humanitarian organization focus is absent
Log 6.5 (Médecins Sans Frontières)	• Report configuration • Project orientation • Standard and non-standard item categorization • Auto-item code generation • Supports local procurement reasonably well • Reasonably good process coverage	• Installation process • Planning • User help documentation for workflow details
Humanitarian Logistics Software (Fritz Institute / IFRC)	• Combines mobilization, procurement, tracking, and reporting • Good interfaces and connectivity	• Enterprise software that requires significant investment and implementation • Does not capture loss

Table 2 Strengths and Weakness of Commodity Tracking Systems (Lee, 2004)

Moving toward the future, organizations should employ information technology solutions

that bring information together across functional areas and between organizations (Lee, 2003). If

this information is timely, complete, and captures losses, better decisions can be made that

benefit the beneficiaries, donors, and the organizations themselves.

4 The Relief Chain

There is a lot of logistics. You can't just truck it out and drop it off. You need a
warehouse. You need a distribution system. You need to locate who is in need. We are trying to
put a system in place so the right people get the food.
 –Eileen Burke, spokesperson, Save the Children (Overland, 2005)

Humanitarian logistics involves delivering the right supplies to the right people, at the

right place, at the right time, and in the right quantities (Cottam, Roe, & Challacombe, 2004;

WFP, 2005). It includes traditional supply chain activities such as planning, forecasting,

procurement, transportation, warehousing, and delivery and supplemental ones such as appeal

and mobilization. The vital role of the relief supply chain is clearly seen in the context of

disaster management cycle (see Section 3.3). The relief chain links all of the stakeholders in the

relief process – donors, humanitarian organizations, military, governments, and beneficiaries.

4.1 Relief Chain Processes

In relief operations, logistics are required to organize and implement the efforts of

organizations responding to a crisis. This is not a simple matter. Often large amounts of people,

food, shelter, clothing, heavy machinery, and medical supplies must be moved into and around

the disaster area using many different modes of transportation. Lives are at stake. This must be

done quickly, while holding down costs. Haghani and Oh (1995) describe the relief chain as a

multi-commodity, multi-modal network flow problem with time windows. This is one of the

most complex network flow problems in operations research. The management of this difficult

supply chain directly affects program quality.

Anisya Thomas, Managing Director of the Fritz Institute, subdivided the humanitarian supply chain into the following process. It was further modified by Mitsuko Mizushima, Chief Logistics Officer of the Fritz Institute, in preparation for the Humanitarian Logistics Conference in Geneva, April 24-26, 2005. The process is pictured in Figure 4.

Communication, Collaboration and Coordination

Relief Chain

| Preparedness | Assessment / Appeals | Resource Mobilization | Procurement | Transportation Execution | Tracking& Tracing | Stock Asset Management | Extended Point of Delivery | Relief to Beneficiaries |

Monitoring / Evaluation / Reporting
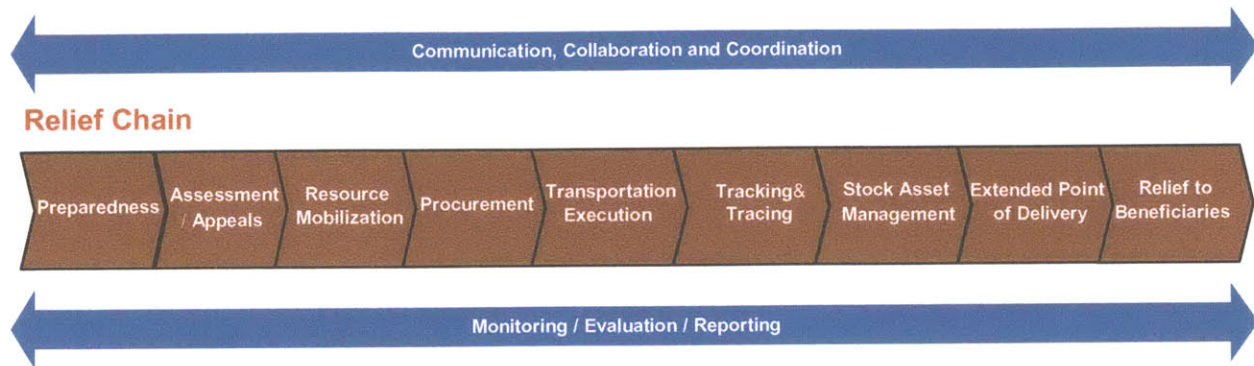
Figure 4 Relief Chain (Thomas, 2004) modified by Mizushima

4.1.1 Planning and preparedness

Before a disaster, logistical procedures and activities must be planned. Improvised procurement and transportation activities are less effective. A plan includes what tasks are to be done, what part of the organization will be responsible, and how to procure needed resources. They must also have a national or regional plan based on the vulnerabilities of the infrastructure, the logistical support in the area, and governmental emergency response abilities. It is not possible to anticipate how crises evolve, but it is advantageous to have a plan. If enough planning is in place with realistic 'if-then-else' cases, implementation can be less challenging (Koech, 2005). The UNJLC is making preparedness plans for South Sudan for the possible return of refugees and Internally Displaced Persons (IDPs). They hope to plan for future trouble spots and active the plans if possible before the emergency breaks out (Synthesis review of the UNJLC - 2nd draft report, unpublished document, 20 March, 2005).

4.1.2 Assessment

Assessment fulfills the roles of demand planning in the relief chain. After a disaster, assessment establishes the needs of the population, the local infrastructure capacity, the level of damage to the infrastructure, and the local resources available. Without performing a basic assessment, it is difficult to know what is needed, how much is needed, when it is needed, and where it is needed.

Assessments are generally composed of several activities: preparedness planning, survey and data collection, interpretation, forecasting, reporting, and monitoring. Preparation identifies what information should to be obtained. There are various methods used to obtain data. They range from visual inspection and interviews by specialists, to statistical sampling, to a checklist. An assessment team reports the data analysis and thoughts about future developments to the appropriate parties. As assessments are just a snapshot in time, they should be revisited and compared with previous results. The report should include the current food, health, water and sanitation, and shelter situation. It should mention capability / capacity of local resources and if any effort at coordination is underway. Lastly, it should speak to the logistics, by describing how to get relief to people, the state of the roads, seaports, airports, and the costs and availability of transportation.

4.1.3 Resource Mobilization

Before the response to a disaster begins, an organization obtains and sets into motion resources. Financial resources must be mobilized to begin procurement, to send personnel across the globe, and to acquire vehicles, warehouses, and other tangible parts of the relief supply chain. Human resources must be mobilized. Trained personnel are not easy to come by. Humanitarian

organizations have several procedures in place to staff for operations. They have full-time staff. They call prepared rosters of people available to work. They also hire short-term contractors.

4.1.4 Procurement

Emergency supplies enter the relief chain through different sources, forms, and locations. They can be given as donations, grants, or gifts-in-kind (non-monetary goods and/or services). These donations can be solicited or unsolicited. Often unsolicited donations are goods that are not a priority and have not been requested. Aid can be multilateral, administered by international institutions which collect resources from countries and redistribute them, or bilateral, given directly from a donor government to a recipient country. Procurement can be done at the local level or sourced globally. Goods can be acquired in many different ways such as in bulk or stored at the vendor until needed.

For example, a large relief organization such as the International Federation of the Red Cross (IFRC) tries to source supplies locally at the disaster site as much as possible. However, the IFRC also pre-sources by region through the following regional supply headquarters: Africa (Johannesburg); Europe (Turkey); Asia (Kuala Lumpur); Middle East (Geneva); and the Americas (Panama). This regional procurement is done to obtain the low prices and high value while minimizing shipping costs. The IFRC also maintains strategic agreements with international suppliers for items used consistently in disasters, such as blankets, tents, tarps, certain emergency rations, and WHO medical kits (Sowinski, 2003).

4.1.5 Transport

Transportation makes it possible for assistance to reach those in need. Transportation in a disaster or humanitarian emergency can run the gamut. It can involve global sourcing, drop shipment, military transport, commercial transport, non-commercial transport, third-party

logistics firms, freight forwarders, charter aircraft, or even local transportation such as mules and donkeys. Goods are often brought into a country at an entry point and then moved to collection sites run by relief organizations.

For example, during the Tsunami international an illustrative relief shipment could have arrived in Indonesia in Jakarta through commercial transport by sea from Singapore. From Jakarta, it was flown by charter aircraft to Medan in Sumatra and stored in an organizations regional warehouse. When it was needed, the shipment was loaded on an International Organization for Migration (IOM) caravan headed to Banda Aceh. In Banda Aceh, it was unloaded from the large IOM trucks and delivered by smaller vehicles to the beneficiaries.

During the Tsunami, lack of transportation caused problems. As the volume of flights into the small airport of Band Aceh built to five times the normal activity, a logjam of relief supplies started to build up. With its single runway, the airport could only handle two planes at a time - one unloading and one landing. As planes were unloaded, the goods were placed out in the open on the tarmac. This space quickly filled up as there were not sufficient vehicles to transport the supplies to those in need.

4.1.6 Tracking and Tracing

Tracking and tracing are not synonyms in logistics. Tracking is the process of building a history of shipment movements from origin to destination. Tracing describes the process of retrospectively determining where a shipment was during the course of a move. Both terms are used in conjunction as Tracking and Tracking to describe the process of gathering information about the current position or status of shipments.

Tracking and tracing is not well developed in the relief chain. In fact, tracking is usually done in Excel. Tracing is not particularly beneficial for relief logistics. It is important to know

what has been promised, what has been ordered, what is on the way, and what has already arrived. The resulting lack of visibility into inbound shipments impedes the task of receiving, clearing customs, shipping to intermediate warehouses, and distribution at each step of the supply chain.

This is an area where the software can contribute. For example, Humanitarian Logistics Software (HLS), developed by the Fritz Institute for use by the IFRC, is a web-based solution that proved visibility from the shipping origin to the destination. This allows both the donors and the organization to have overall pipeline visibility. The web-based nature of HLS speeds up information sharing and allows logisticians the opportunity to plan appropriately for customs, off-loading labor, and transportation requirements.

4.1.7 Stock Asset Management

In the relief chain, stock can accumulate in many places. Collection sites can act as transshipment points, warehouses, and as places to prepare and pack goods. They can be located in impacted areas or near ports, border crossings, or airports. At this stage, notification of the receipt of the goods should be sent, records of inbound supplies should be maintained, and supplies must be secured to prevent theft and spoilage. Loads should be inspected to ensure that they correspond to the shipping papers and that they are not contaminated. If goods are contaminated, reverse logistics come into play. The goods must be returned, given to livestock, or destroyed.

During the 1984Ethiopian relief efforts, the port in Assab experienced major congestion. Due to the shortage of trucks to remove shipments from the port area, ships often had to wait for up to nine days before docking. Compounding this problem donor ships arrived concurrent with commercial goods such as fertilizer and grain, which competed for unloading with relief

shipments. Un-removed goods were left in substandard storage areas. Despite efforts to protect exposed bags of grain from sun and rain with tarpaulins, losses occurred due to spoilage. (Stevenson, 1993)

4.1.8 Extended Point of Delivery and Relief to Beneficiaries

The last two links in the relief chain encompass the last mile of relief work. An extended delivery point is an inland destination close to the affected area where goods can be staged before the final distribution of relief to beneficiaries. In most relief operations, supplies are brought close to the refugee camps for storage. Daily relief organizations bring food aid to camps, prepare it if necessary, and disperse it.

Humanitarian logistics endeavors to bring assistance to people affected by a disaster. This assistance must be distributed to those who truly need it in proportion to their needs in a culturally appropriate manner. To ensure these conditions are met there must be monitoring, not only at the storage stage, but throughout the distribution of supplies. They take care to ensure vulnerable populations receive their share of the food distribution. This can take the form of distribution via identity cards or by giving female heads of household food for the family.

4.1.9 Monitoring, Evaluation, and Reporting

Monitoring is the regular collection, analysis, and utilization of information about the supply chain performance. Evaluation is the periodic assessment of the relevance, efficiency, effectiveness, impact, and sustainability of the supply chain. It is done in order to adapt the supply chain to current circumstances. Reporting is completed after information has been collected, compiled, and summarized. The information is used to formulate conclusions and recommendations for the supply chain.

Most humanitarian organizations do not measure their relief chains beyond the time from order to delivery. The establishment of key performance measures enables the alignment of an organization's strategic objectives to its logistics strategy. To ensure this, humanitarian organizations could measure their relief chain's budget performance, velocity performance, efficiency, and quality.

Monitoring and evaluation create the information base for decision-making during the implementation of the relief chain. At the very least, a simple monitoring system enables management and staff to evaluate the differences between planned and actual performance. The difficulty for humanitarian organizations is that information technology (IT) systems that can provide the data necessary to correct performance are expensive and require training. Many relief organizations prefer to spend their money on programs rather than IT systems. Regrettably, the quality of relief provided suffers in the end because institutions do not have a clear picture of their own performance. See Section 4.3.3 for a discussion of software created to address this issue.

4.1.10 Communication and Collaboration

Communication is often difficult in a disaster setting, but it can make all the difference. Accurate information or even just visibility into the rest of the relief chain helps. Collaboration refers to work done along a single organization's supply chain or in cooperation with another agency, for example, efforts to work more smoothly with your supplier or sharing resources with another NGO, such as a warehouse.

Technology can improve both communication and collaboration. Chapter 4 details the development of technology use in a disaster setting. Section 4.3 discusses current technology trends and practices that relate to communication and collaboration.

Humanitarian organizations often use the terms collaboration and coordination interchangeably. In this thesis, collaboration conveys cooperation between two agencies or along a single relief chain, while coordination denotes the organization of efforts by a group.

4.2 Importance of Coordination

Disasters place extraordinary stress on the logistics of responding organizations. Coordination can reduce and manage the stress. The most cited definition of coordination in humanitarian assistance is from the Humanitarianism and War Project.

> The systematic use of policy instruments to deliver humanitarian assistance in a cohesive and effective manner. Such instruments include: (1) strategic planning; (2) gathering data and managing information; (3) mobilizing resources and assuring accountability; (4) orchestrating a functional division of labor in the field; (5) negotiating and maintaining a serviceable framework with host political authorities; and (6) providing leadership (Minear, 2002).

When disaster strikes, dozens of diverse organizations operating with different mandates converge on a disaster site all setting up facilities and infrastructure. Congestion often limits the availability of relief supplies. Competition for locally available commodities and services (such as trucking or housing) can drive prices up by a factor of ten. Fragmentation occurs as each agency responds in a coordinated fashion, but does so independently and does not coordinate with other agencies.

When agencies and actors on the ground cooperate through command structures, primarily but not only UN coordination mechanisms, coordination takes place. At the very least, coordination strives to prevent duplication of efforts between different aid organizations. In the best of circumstances, coordination ensures all the organizations fit into a coherent and successful response. Coordination can be strategic, in pursuit of a common policy or strategy, or it can be operational, such as regular sharing of logistics or program information. Effective coordination begins before a disaster occurs and continues throughout the event.

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Coordination must fight against humanitarian organizations' strategies for survival. These organizations operate in a market. They must all generate and sustain resources in order to survive. "Fundraising strategies depend on skills such as the marketing of suffering, enhancing image, buying donor fashions, competing for credit and visibility, and selectively avoiding coordination mechanisms" (Walkup, 2001). These activities guarantee survival.

Coordination is usually seen in a positive light. Each situation faced by organizations working in relief options is unique. The ever-changing shape of natural disasters and man-made conflicts continuously presents new challenges. Coordination issues often arise. Many authors argue that coordination is important due to possible gains in program effectiveness, although there is no consensus on what is meant by effectiveness (Minear, 2002; McEntire, 1997). Responses must be coordinated, both among NGOs and in regard to the broader emergency (Okasaki, 2003). Advantages can be found in pooling information and resources and in forming alliances that allow each organization to contribute its core competence. While these advantages are significant, care must be taken to ensure that impartiality and independence, both fundamental principles of humanitarian assistance, are not compromised (Eade & Williams, 1995). Coordination is also offered as a means to avoid duplication of efforts.

Antionio Donini (1996) proposed dividing coordination into a three part typology of coordination by command, consensus, and by default. Coordination by command demands leadership authority. Coordination by consensus uses persuasion and less authority. Coordination by default has few means to enforce action and no real authority (Sommers, 2000). In a review of recent field experience, the United Nations Office for the Co-ordination of Humanitarian Affairs (OCHA) found that a command or control element was required for an effective humanitarian response (Reindorp & Wiles, 2001). Possibly because no other choices

are available, the UN directs coordination by default in most situations. As a result, it names a lead agency. There are no clear requirements or duties of a lead agency. While not ideal, it is an attempt to increase coordination and effective humanitarian action.

4.3 Logistics Flows

In addition to the physical distribution of final products, logistics comprises financial and information flows. Railroads, motor vehicles, ocean shipping, and aviation represent physical logistics. More efficient information exchange translates directly into better physical and financial logistics. Physical flows occur between the following relief chain processes: resource mobilization, procurement, transportation, stock asset management, and extended point of delivery. Information flows connect the following relief chain processes: preparedness; assessment & appeal; track and trace; monitoring, evaluation, & reporting; and communications. Financial flows take place during the subsequent processes: preparedness; assessment & appeal; procurement; and monitoring, evaluation, & reporting. Figures 5, 6, and 7 illustrate these flows along the relief chain.
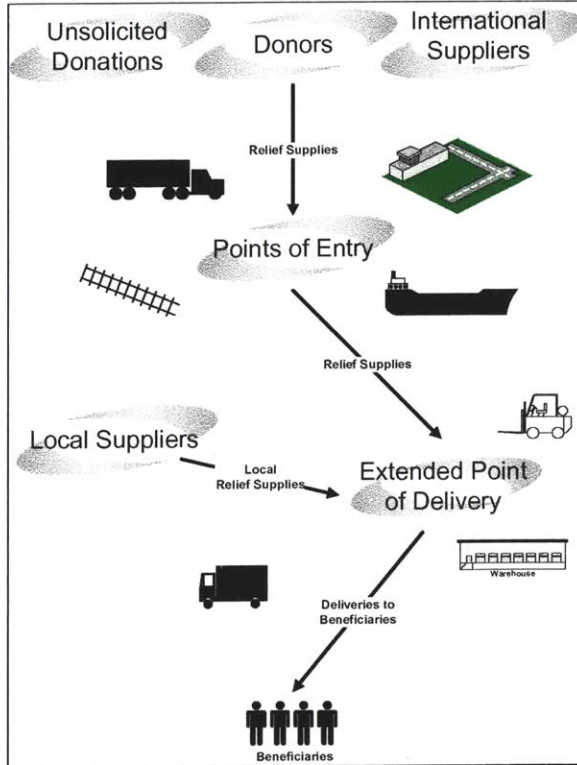
Figure 5 Product Flows
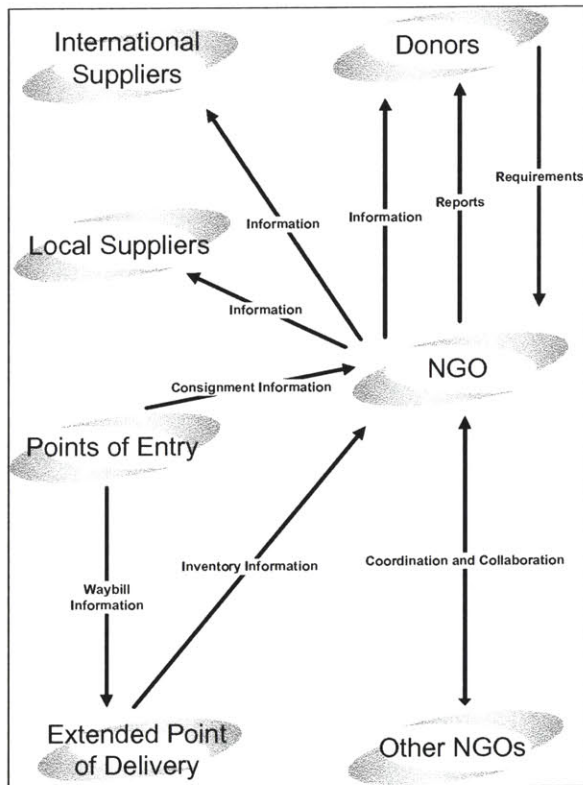
Figure 6 Information Flows
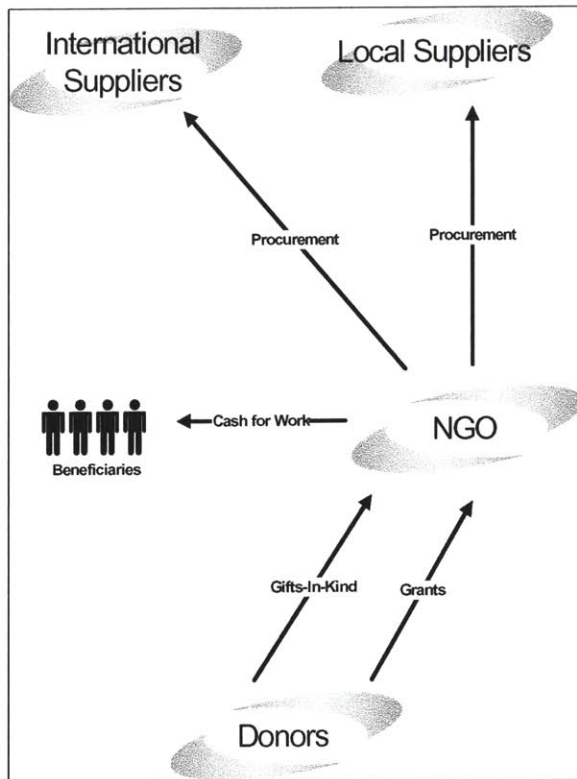
Figure 7 Financial Flows

5 Methodology

Complex humanitarian emergencies and natural disasters destroy infrastructure and place communities at risk. NGOs are a primary source of relief to the affected communities. Logistics is central to this aid, but there is little research about appropriate logistics structures and practices and there are few humanitarian workers with professional training in logistics. Most of the learning that occurs about relief supply chains is anecdotal. A more formal understanding of current practices and the state of the relief supply chain is necessary to guide future research and improvement efforts.

In December, the 2004 South East Asia Earthquake and Tsunami captured all of the world's attention. After going to observe organizations in Indonesia, Thailand, India, and Sri Lanka, the Fritz Institute decided to develop a survey to learn how relief supply chains were operating. Founded in 2001 by Lynn Fritz and Dr. Anisya Thomas, the Fritz Institute is dedicated to bringing the experience and best practices from the commercial sector and expertise from the academic community to bear on the logistics problems of humanitarian relief agencies.

In partnership with KPMG, the Fritz Institute created a survey concerned with supply chains used in the Tsunami relief effort that followed the processes outlined in Chapter 5. The Fritz Institute distributed the surveys while the organizations were still actively involved in the relief effort. The surveys collected data on the whole relief chain and sought to determine issues that hampered relief efforts. The Fritz Institute's goal was to share the results with the

organizations, create a plan to address identified issues, and establish baseline data to be used in benchmarking and designing the next generation of surveys.

Thirty-nine international humanitarian organizations actively responding to the Tsunami relief effort received the survey. Eighteen completed surveys were returned for a response rate of 47%. Since multiple staff members worked on a single response from each organization, almost 100 people contributed to the surveys. Six of the organizations were affiliated with either the United Nations or the Red Cross Movement. These are very large established organizations with similar backgrounds and motivations.

This study also reflects interviews, articles in the popular press, and personal observations. It seeks to assess the complexity of humanitarian relief and measure performance. However, the survey was not designed to allow for statistical analysis of the responses. Other limitations are listed below.

Single event – the study examines the response to only one natural disaster. The findings are related to the specific context of this disaster. The scale and magnitude of this disaster may limit the degree to which this data can be generalized to other contexts.

Insulated perspective – The survey interviewed organizations alone about their supply chain, while the beneficiaries, other actors in the field, or government officials were not consulted. Concentrating on this perspective is reasonable scope for this analysis. The Fritz Institute is conducting further surveys of beneficiaries, governments, military, and local NGOs.

6 The 2004 South East Asia Earthquake and Tsunami

"What happened on 26 December 2004 was an unprecedented, global catastrophe. It requires an unprecedented, global response."
- Secretary-General Kofi Annan
Statement in Jakarta, Indonesia, 6 January 2005
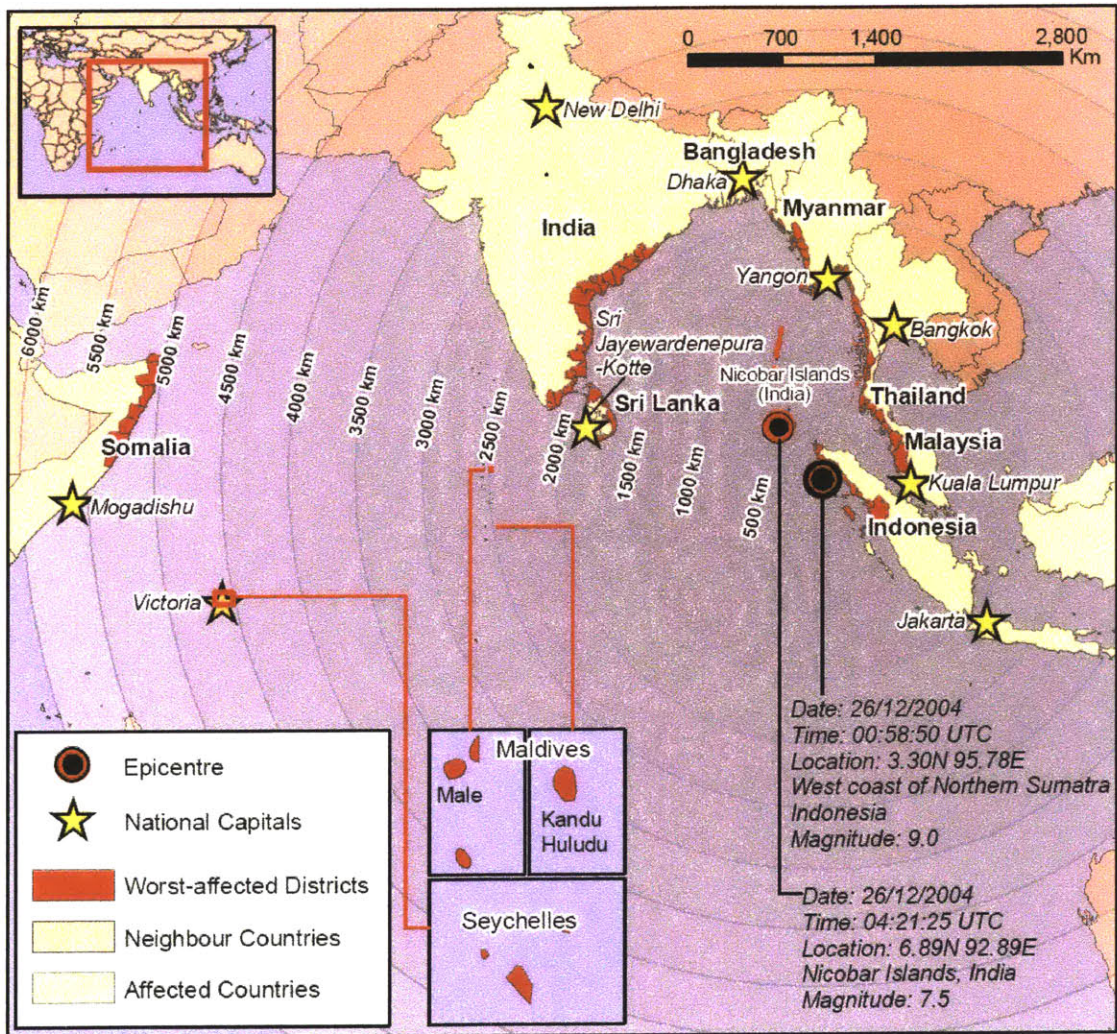
Figure 8 OCHA Situation Report No. 20 Jan 20, 2005 (OCHA, 2005)

6.1 The Events

At two minutes to eight in the morning on Boxing Day, December 26, 2004, an earthquake tore through the seafloor off the coast of northwest Sumatra. Billions of tons of seawater forced upward by the movement of the sea floor flowed away from the fault in a series of giant waves. Fourteen hours and twelve countries later the waves rushed ashore on the eastern coast of Africa.

6.1.1 The earthquake

Over a century of accumulated strain was released in possibly the second biggest earthquake in recorded history. Determining the magnitude of earthquakes larger than 9.0 is difficult. Currently there is not a consensus on the size of the earthquake on December 26th, 2004 (*USGS Earthquake Hazards Program: FAQ: off W coast of northern Sumatra*, 2005). Routinely used techniques place the magnitude of the earthquake at 9.0. New analysis by seismologists from Northwestern University estimates the magnitude at 9.3. Because the Richter scale is logarithmic, this 0.3 change corresponds to a three-fold increase in intensity. This presents a problem when comparing earthquakes. Older earthquakes were not recorded using the same type of equipment that led to the revised estimate and can never be adjusted upward in the same manner. The only recorded earthquake of a higher magnitude, 9.5, occurred in Chile on May 22, 1960 (Schirber, 2005).

The 2004 South East Asia Earthquake occurred in the Andaman-Sumatran subduction zone, where the India plate pushes underneath the Burma Plate. When the India plate slipped thirty-three to fifty feet under the Burma plate, a section of the ocean floor was displaced vertically, forcing water upward. The water swelled up, sending waves outward creating tsunamis.

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Locations as far away as the Maldives and Thailand reported shaking from this subduction earthquake. The earth shook for about eight minutes, quite unlike the more familiar strike-slip, horizontally orientated earthquakes of Kobe or Southern California that last for a few seconds. The rupture zone was very large at over 750 miles long. Shortly afterward, several severe aftershocks followed. One of them reached a magnitude of 7.3 and lasted one and a half minutes.

6.1.2 The Tsunami

The Japanese word tsunami translates as harbor wave. Often tsunamis are incorrectly called tidal waves. Tidal waves are normal movements of water associated with the weather and tides. Tsunamis are caused by other factors and refer to a series of waves with extremely long wavelengths traveling across the ocean (*Pacific Tsunami Museum FAQs*, 2005). In the deep ocean, there can be hundreds of miles between wave crests. As these waves approach shore, the drag caused by the rising sea floor slows down the waves causing the wave height to increase dramatically. When tsunamis strike shore, they quickly flood low-lying coastal areas producing wide spread loss of life and destruction.

6.1.2.1 How do earthquakes generate tsunamis?

The most destructive tsunamis are generated from large, shallow earthquakes with an epicenter near or on the ocean floor. These usually occur in areas of subduction along tectonic plate boundaries, such as the Andaman-Sumatran subduction zone where the 2004 South East Asia Earthquake took place. As these plates move past each other, they cause large earthquakes, which displace large sections of the ocean floor. Sudden vertical displacements over such large areas displace water and generate destructive tsunami waves. The waves travel great distances from their source, causing destruction along the way. For example, the Great 1960 Chilean

tsunami was generated by a magnitude 9.5 earthquake. Its waves were destructive not only in Chile, but also as far away as Hawaii and Japan. Not all earthquakes generate tsunamis. Usually, it takes an earthquake with a Richter magnitude exceeding 7.5 to produce a destructive tsunami. (*International Tsunami Information Center - frequently asked questions*, 2005)

6.1.2.2 Tsunami Historical Context

Tsunamis occur in all of the world's oceans. Most tsunamis are locally destructive events that occur near inland seas. They are usually far more localized than the South East Asia Tsunami. Over the last century there have only been a handful of ocean wide tsunamis: the April 1, 1946 Aleutian Earthquake and Tsunami – a magnitude 7.8 earthquake spawned a tsunami that killed 159 people in Alaska and Hawaii; the November 4, 1952 Kamchatka Earthquake and Tsunami – a magnitude 8.2 earthquake caused a tsunami that damaged regions from Russia's Far East to Peru and Chile; the March 9, 1957 Aleutian Earthquake and Tsunami – a magnitude 8.3 earthquake in Alaska generated a Pacific wide tsunami but no lives were lost; the May 22, 1960 Chilean Earthquake and Tsunami – the largest recorded earthquake, magnitude 9.5, occurred off the coast of Chile setting off a tsunami that killed 2,361 people from Chile to Hawaii; and the March 28, 1964 Alaska Earthquake and Tsunami – a magnitude 8.4 earthquake in Alaska created a tsunami that killed over 120 people and impacted the western coast of North America from Alaska to Los Angeles (IOC, 2001). The 2004 South East Asia earthquake and tsunami was exceptional in that it was a multi-country, multi-continent event that came and went very quickly.

Other events have similar death tolls and cause similar types of damage. On November 12, 1970, a cyclone struck Bangladesh and the resultant storm surge killed over 300,000 people in one night. This is unusual due to the enormous spread of the destruction occurring

simultaneously across hundreds of miles of coastline. Several million survivors of last year's

Tsunami face years of painful and uncertain recovery, having lost breadwinners and family

members, homes and livelihoods (Darcy, 2005).

6.1.3 Impact

The popular press labeled the South East Asia Earthquake and Tsunami the worst natural

disaster ever. This is debatable. Several disasters have killed more than the Tsunami. The 1976

Tangshan, China earthquake possibly killed 600,000 people. The 1970 cyclone cost the new

state of Bangladesh an estimated 500,000 people. The estimated death toll for the Tsunami

stands at 300,000 people. The actual figure for the Tsunami is unlikely to be established with

any degree of certainty. In Indonesia in particular, 500 bodies a day were still being found in

February 2005 and the count was expected to extend past June (Task of collecting Indonesia's

tsunami victims could continue beyond June, aid official says, 2005). The difference between

these other disasters and the Tsunami is the extent of the damage. The damage from the

Tsunami ranged across 13 countries, stretched along thousands of miles of coastline, and

affected millions of people.

Less that thirty minutes after the sea floor shifted 65 feet vertically, the first wave struck

Sumatra. The waves in Meulaboh, the remote town closest to the epicenter, reached a height of

65 feet. The Tsunami killed an estimated 40,000 of its 90,000 people. The city of Banda Aceh,

at the northern end of Sumatra, was almost wiped off the map. 200,000 people are believed to

have died there. The waves changed direction and continued around the tip of Sumatra. As

shallow depths slowed the part of the wave closest to the shore, the outer part of the wave

continued traveling at high speed and bent around the island. This phenomenon is called as

refraction.

An hour after the earthquake the waves arrived on Thailand's shore trough first. This caused the dramatic receding of the sea that enticed those unfamiliar with tsunamis and children to the seashore. It preceded the arrival of the thirty-foot crest by only a few minutes. Thailand's popular resort areas were hard hit.

At the same time, the waves crossed the Bay of Bengal encountering the low-lying Andaman and Nicobar Islands first. Next, the waves reached the eastern coast Sri Lanka and Southern India. These waves came ashore without receding, destroying beaches, villages, and coastal cities. Sri Lanka also experience refraction of the waves around the northern and southern end of the island nation, causing damage along a majority of its coastline.

The waves continued across the Indian Ocean. The Maldives, one of the lowest lying countries, was completely submerged, but not hard hit. The geography of the islands, tips of seamounts, protected them from the frightening wave heights experienced elsewhere. Finally, some seven hours later, the Tsunami washed against the eastern coast of Africa. In Somalia, 300 people were killed. Warning reached Kenya in time and people were warned to stay away from coastal areas. The energy of the Tsunami did not dissipate there. Sea disturbances were reported as far away as South Africa and Mexico. Manzanillo, Mexico, reported 8.5 feet sea level fluctuations.

The long-term economic impact of the disaster is difficult to measure. Some economies seem to have escaped unscathed; for others, the impact will be deep and long lasting. The UN's Financial Tracking Service (FTS) is a real-time database of humanitarian aid managed by OCHA. It covers UN funding as well as outside appeals such as, NGO funding, bilateral aid, in-kind aid, and private donations. FTS tracks contributions, actual payments of funds, commitments, contractual obligations between donors and recipients, and uncommitted pledges,

announcements of intended contributions. At the time this thesis was published, OCHA reported $2,745,763,468 USD in contributions and commitments for Tsunami relief and recovery efforts. An additional $4,105,817,979 USD had been pledged but not yet committed (FTS, 2005). That totals $6.8 Billion USD for relief and recovery. In comparison to other years, this sum is staggering. In 2005 the total was $569 Million USD. Over the last five years OCHA reported an average of $361 Million USD per year. The International Monetary Fund and the World Bank estimated the macroeconomic damage at $7 Billion USD. Other estimates from insurance companies have been almost twice that amount. It may take years before the true scope of the economic damage is known.

6.2 Relief Efforts and Pain Points

During any relief effort problems, obstacles, and hindrances can derail or delay the delivery of goods to those in needs. These pain points are seen repeatedly in relief efforts around the world. This section of the chapter describes several pain points in detail using examples from the Tsunami and previous relief efforts.

6.2.1 Unsolicited and Unsuitable Goods

The Tsunami has generated an incredibly generous response. A portion of that response has been unsolicited goods donated by individuals, groups, and corporations. These donations can be ineffective, consume precious time and resources, and do not respect the human dignity of those in need.

Relief aid is sensitive to context. In general, goods are location sensitive and expensive to transport, due to both weight and the location of the people that need it. The beneficiaries are often in hard to reach locations or in places with damaged infrastructure. The goods need to be

culturally and technologically appropriate. These facts appear straightforward, yet almost every disaster and complex humanitarian emergency encounters unsolicited and unsuitable goods.

In Sri Lanka, unwanted aid piled up at government buildings, aid agencies, and refugee camps. Many weeks after initial appeals for water, significant numbers of boxes of bottled water continued to arrive after the water and sanitation services were restored. The water is heavy and expensive to transport. Winter jackets, winter tents, expired cans of salmon, cologne, high-heeled stiletto shoes, and sequin-studded black evening dresses were sent by well meaning people and organizations (Barta & Bellman, 2005). More widely reported were the "well-intentioned" donations of thong panties and Viagra from Australia. Some items, while useful themselves are not appropriate technologically. For example, victims living in camps without can openers cannot easily consume the canned food donations. A gift of baby bottles could not be sent to refugees that lacked the ability to sterilize them. Other items are not culturally appropriate. Bath gel, lotion, and other western cosmetics are novel and confusing. Used clothes, kitchen utensils, and pots and pans serve to frustrate those who they are trying to help. In the camps were the refugees live, these clothes are used as potholders when cooking over open fires (Senanayake, 2005). The victims of the Tsunami would be better served if money were sent to relief workers in the region that know the needs and cultural sensibilities of the people that they are serving.

Problems of technical and cultural appropriateness have been encountered in other emergencies. In Haiti, relief agencies brought in dried beans to help feed those left homeless after a hurricane. While the dried beans were light and inexpensive to ship, they caused much hardship for the refugees. Before the beans could be eaten, they had to be boiled for hours. The refugees could not find clean water and fuel (J. Leaning, personal communication, February 11,

2005). Along the same lines, pork products were brought into Bosnia and Somalia to feed Muslims, who have religious restrictions on pork.

Used donations, while not necessarily goods with the most primary need, also affect efforts in another less tangible way. The victims of any disaster are living in difficult and sometimes dangerous situations. They have the right, as do we all, to live in dignity and be treated with respect. Donations of used and soiled clothing, kitchen supplies, footwear, and expired medicines all show a lack of respect for their human dignity. This problem was compounded because some Sri Lankans feared the used clothing was removed from dead bodies. Expired medicine has been sent as relief aid, which is a clear failure of the supply chain and is an actionable offense. Refugees now look at the expiration date before they accept any medicine being offered them (Cohen, 2000).

Drug donations in emergencies are essential, but they can cause harm as well as good. Drug information is in unknown languages, many donations are expired or about to expire, and some do not correspond to the country's disease patterns. In 1997 a study by Epicentre and Pharmaciens sans Frontières estimated 50-60% of donated drugs in Bosnia were inappropriate (WHO, 1999). In the aftermath of the 1998 Armenian earthquake, only 30% of the drugs were usable by the health workers in Armenia (Hairapetian, 1998). In 2004, a Michigan based NGO brought expired high blood pressure medicine, not appropriate in a camp with a starving population, and a film crew to Darfur (M. VanRooyen, personal communication, March 18, 2005). In the early 1990s, United States pharmaceutical companies shipped tons of expired medicine to Somalia in order to relieve themselves of useless inventory and to receive tax deductions. Similar problems have been reported in Rwanda, Kenya, Honduras, and Turkey.

Wasted time and effort are other negatives associated with unsolicited donations. One of the survey respondents wrote about a shipment of unsolicited medical supplies. It took three weeks of one person's time to unload and catalog the supplies. When an unsolicited shipment arrives, an organization must spend time and energy cataloging the goods and clearing customs. In Sri Lanka, an organization related its experience with a shipment of used clothes. After spending time getting the goods through customs, cataloging and separating them, and shipping them out to be distributed, the local population would not accept them. They felt that they should not be expected to wear clothes that someone else threw away.

6.2.2 Infrastructure

In relief work, both in disasters and complex humanitarian emergencies, damaged infrastructure, inaccessible infrastructure, and the lack of infrastructure needed for large-scale assistance lead to bottlenecks, delays, and congestion at entry points to the disaster area. As goods flood into a region, they can be held up at the ports, border crossings, and airports due to lack of transportation, permission to enter certain areas, or even roads. This is a problem across all relief chains, and those employed during the Tsunami were no exception.

As the water rushed ashore, it damaged all of the infrastructure in its path. This included coastal roads, bridges, warehouses, airports, ports, vehicles, and communications infrastructure. As the water receded, it left debris covering everything, both infrastructure it damaged and infrastructure it left intact. The infrastructure that was in place before the Tsunami was rendered useless until repair and clean up operations could be completed.

As aid began to arrive in the region, the lack of infrastructure prior to the Tsunami exacerbated the problems. The demands placed on this infrastructure by the relief chains revealed deficiencies in the undamaged infrastructure: a lack of available vehicles, insufficient

fuel storage, runways too small to manage cargo planes, inadequate warehouse space, and scarce air traffic control.

The lack of infrastructure appropriate for a large-scale relief operation coupled with damage to a portion of the infrastructure that did exist produced one of the biggest challenges - congestion. In Sumatra, for example, the major airports and seaports were open; the infrastructure beyond them was damaged. Banda Aceh's small airport went from three flights a day before the disaster to round-the-clock traffic. Undamaged vehicles were in short supply and had difficulty moving through the region. The few vehicles that could get through were large trucks that traveled on cleared roads and hence, could not reach those most in need. As a result, helicopters became a much-coveted asset. This is also true in Darfur and the high plateau region of Ethiopia. It is easier to fly in supplies than to get them there overland. Insufficient ground crews to handle goods slowed the unloading of planes. At one point, a cargo plane hit a cow at the only airport in Aceh and damaged the plane, blocking the runway and halting relief flights for a day (Djuhari, 2005). Limited storage space led to offloaded cargo that quickly filled available tarmac space. Communication problems and poor information technology infrastructure caused very limited visibility into incoming shipments. It was hard to know what is in a shipment, when it was coming, and who was coming to pick it up.

6.2.3 Political Pressures

In some cases, Tsunami aid became politicized adding unpredictable constraints to the relief logistics. Both national and dissident groups wanted to control aid for areas of Indonesia and Sri Lanka that have been the subject of internal security disputes. Customs regulations became a tool used by the government to shape organizational responses. India turned down Tsunami relief as part of a deeply rooted political stance. The Indonesian government denied the

US military permission to land in Sumatra. A senior U.N. relief official chided wealthy Western nations for being "stingy" with their aid in an attempt to apply political pressure. Even visits by dignitaries slowed relief efforts. All of these political acts have supply chain consequences.

He who controls the money has the power. This truism holds in conflict areas. In Sri Lanka, both the Liberation Tigers of Tamil Eelam (LTTE) and the government want to control aid flows. The rebel-controlled areas had already suffered heavily because of the war and were then hard hit by the Tsunami. While the Sri Lankan government wanted to channel the aid, the LTTE wanted to disburse the aid via the Tamil Rehabilitation Organization (TRO) in rebel-controlled areas. The LTTE argued that the area under their control had received almost no government aid and neglected when compared to the Sinhala dominated south. The TRO went to work immediately following the disaster registering survivors and dispersing aid.

The situation in Indonesia was different. In Indonesia the difficulty was not competition to control aid, but access to the damaged area. For the past three decades, a brutal conflict between Indonesian security forces TNI (Indonesian military forces) and separatist rebels of the Free Aceh Movement (GAM) has marred Aceh on the northern tip of Sumatra. When the Tsunami hit, the rebels were largely spared because they were hiding in the mountainous interior, though almost all lost family members. The Tsunami affected the TNI much more because they were patrolling the cities along the coast. Aceh, previously closed to international aid workers and journalists, suddenly became open again. The GAM is not as organizationally capable as the Tamil Tigers in Sri Lanka. Instead, the TNI control the tent cities, relief camps set up for the Tsunami survivors. Several times in late January, the TNI moved relief camps overnight citing security concerns (Hilarie Cranmer, personal communication, February 18, 2005). Relief agencies would arrive in the morning and find the people they came to vaccinate and feed were

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no longer there. Survivors called memories of relocation camps that were established by the TNI during martial law in the 1990s, when the government made a big push to defeat GAM. At several points, the Indonesian government threatened to deny visa renewals for relief workers in an effort to control access to the area.

The Tsunami offered all sides an opportunity to set aside their differences and involve themselves in relief and rehabilitation work. That could have paved the way for better understanding of the genuine problems faced on both sides. Short-term, the fighting subsided, but soon after restarted and intensified. Unfortunately, long-term action requires a political dynamism that appears to be lacking.

Conflict related political concerns are not a Tsunami specific situation. The government in Khartoum, Sudan, does not allow access to all areas of Darfur. Darfur contains over one million internally displaced people in an area roughly the size of France. These people need food aid in camps scattered across an area with minimal infrastructure. Darfur has always been a logistics challenge. In recent months, escalating violence has made it even more difficult. Large areas of Darfur are closed to humanitarian organizations, making it impossible to provide food aid and other assistance.

Immediately following the Tsunami, relief aid started flowing to the hardest hit countries. Customs officials were not prepared to deal with this situation. For example, customs officers on the India and Pakistan border refused to release nine trucks for ten days until payment of a duty or approval from the central government (Indo-Asian News Service, 2005; Rataul, 2005). Much relief was delayed until governments could relax requirements and communicate new rules to customs officials. Radios and communication equipment were treated as sensitive items due to the possibility that the equipment could end up in the hands of rebel groups. The requirement

and polices concerning these goods changed with out sufficient notification or communication. Eventually, the UNJLC placed a person at customs in Indonesia to help solve the communication problem. This is one case where a person made more of a difference than technology.

India turned down relief and help from organizations that were not already working in the area. The Prime Minister informed President George Bush that India had adequate resources to meet the challenge (Duff-Brown, 2004). It has been suggested that India's stance is based on several factors, including its desire to project itself as a self-sufficient regional power and its campaign to become a permanent member of the UN Security Council. India provided relief to other countries. The country took the lead in providing aid to Sri Lanka and the Maldives.

Immediately after the Tsunami, American warships were ordered to sail to the stricken region. As they were rerouted from Sri Lanka to the harder hit western coast of Sumatra, the Indonesian government announced that it did not want marines of the U.S.S. Bonhomme Richard and Expeditionary Strike Group Five to come ashore (Baum, 2005). In light of the Iraq War, the largest Muslim nation did not want to have a U.S. military presence. This political decision limited the response the Marines could offer. Helicopters were able to deliver water, rice, and other goods, but the marines were not able to offer as much logistical support as they had the capability to deliver.

When Jan Egeland, the UN's chief of emergency relief, called rich nations stingy he was applying political pressure. These comments, even though he backed away from them the following day, arguing that he was misinterpreted, improved the financial side of the relief chain. By calling on nations to commit funds to the relief effort, Egeland created the space where planning and mobilization efforts could proceed.

Even something seemingly innocuous, yet political, can affect the supply chain. The politically motivated visits of Kofi Annan and Secretary of State Colin Powell temporarily shut down the airport in Banda Aceh and rerouted planes (Gecker, 2005). Aid groups complained that dignitaries traveling to the region to view the devastation impeded the distribution of relief supplies choked at the airport.

6.2.4 Assessment

Directly after a disaster, work must be done to determine the nature of the disaster, the extent of the damage, the initial needs of the victims, the secondary threats to the population, the local response capacity, the need for international assistance, and the means for delivering any needed assistance. The recommendations must be clear, concise, timely, practical, and operational. They become blueprints for planning disaster response activities (USAID OFDA, 1998; UNDAC assessment procedures, 1995).

In an ideal world, all of the above-mentioned things would be done every time for every disaster, but it does not work that way. It is difficult to reach many disaster sites. Trained local staff is often impossible to obtain. In practice, organizations often send teams with personnel lacking the necessary logistics skills to perform assessments.

After the Tsunami, the hardest hit parts of Sumatra were impossible to visit without helicopters or light planes. The same was true after Hurricane Mitch and during the Iraq War. Damaged infrastructure and dangerous conditions can keep an assessment team away from the areas it needs to visit in order to do a thorough job.

Trained staff can make a huge difference. Local staff who speak the language and know the customs and the population improve the accuracy of assessments. In the aftermath of the

Tsunami, local people were not trained, were victims themselves, or were involved in direct relief activities and were therefore not available. This impacted the quality of the assessments.

Assessments are snapshots of a changing situation and can cause relief organizations trouble. Near Lhokseumawe, a port city in Aceh Province, Indonesia, several makeshift refugee camps were in place. An organization noted their location during an assessment. When the team sent by the organization arrived a few days later, the camp was no longer there (Hilarie Cranmer MD, personal communication, February 18, 2005). The supply chain created to serve that population was no longer optimal and had to be changed. This happens in every refugee camp on a smaller scale as refugees search for family members and leave to live with relatives. The snapshot nature of assessment was demonstrated on a larger scale on the border of the Democratic Republic of the Congo and Rwanda. 500,000 refugees fled the city of Goma as the nearby Mount Nyiragongo let loose a lava flow that ran through the center of town. The refugees crossed the border into Rwanda. Relief agencies planned their supply chains to route aid though Kigali, Rwanda. The refugees remembered the horrors from the camps that were in Goma after the genocide in Rwanda in the early 1990s. Cholera spread through the camps killing many children. Three days later as the volcanic activity subsided, the refugees carried their children across cooling lava flows to go back to their homes rather than put their children at risk. This population movement caused relief supplies to be delayed another week since the supplies brought into Kigali could not be driven across the lava.

6.2.5 Competing Supply Chains

When legions of humanitarian organizations flock to the scene of a disaster to help those in need, they all need many of the same items concomitantly. As each agency sets up its own supply chain and starts procuring necessary supplies, the multiple relief chains can compete

against each other. This is wasteful and slows the relief process. Humanitarian organizations are engaged in a form of market-based survival. They must generate and sustain resources in order to survive. This makes it difficult to eliminate competition of this kind.

In Indonesia, competing supply chains compounded the severe shortage of vehicles. Early on, every vehicle on the market was purchased. This forced other groups to import vehicles from abroad, slowing the relief effort. These competitive problems are not limited to the region. During the first week following the Tsunami, there were stories about hardware stores in Guam and Singapore being emptied out of almost everything in stock. Organizations came in and bought all the shovels, hammers, nails, lumber, and generators (Baum, 2005). In Afghanistan, organizations unknowingly set off a bidding war by competing against other organizations for truck capacity in Herat. Prices increased 300% over six months (Kaatrud, Samii, & Van Wassenhove, 2003). Finally, the UN stepped in and published rates on its website. This transparency brought prices under control. Macedonia, in 1999, experienced a lack of affordable housing due to similar competition. As relief workers arrived to work in refugee camps, organizations willingly paid monthly rents equivalent to a yearlong lease. Subsequently, the remaining available space on the market was priced to match the inflated rents. Locals were no longer able to afford housing because property owners held out for foreign rentals.

6.2.6 Financial Supply Chain

The financial response from public and private donors to the Tsunami was unprecedented. However, before relief can begin to flow, the financial supply chain must be put into place. This is a difficult process in the beginning and takes time. Meanwhile, available cash reserves are quickly depleted. Before the processes for money transfers are in place and agreements with local banks and merchants are formalized, organizations can struggle.

In the first few days, cash flow problems abound. In areas with less developed banking infrastructure, organizations have used their creativity. Workers for CARE brought in suitcases of cash into Southern Sudan to prime the relief efforts in that region (Martha Thompson, personal communication, October 8, 2004). In response to the survey, two NGOs reported difficulties during the early stages of their Tsunami response. They wrote that while financial resources were available, they encountered problems with cash availability. Immediately after the Tsunami, banks were closed in Jakarta due to Christmas holidays and weekends. This complicated cash transfers from Europe and made it difficult to enter into agreements with merchants. Competition can hinder progress in this arena as well. World Vision reported a problem hiring local staff as the cost of hiring labor off the local market was higher than they could offer.

7 Results

What is special about this tsunami is the geographical extent of the devastation and the number of countries affected....That produces a huge logistical challenge for international organisations and aid agencies: how to get relief supplies and, later, reconstruction assistance to so many places at more or less the same time. Much more of the money and planning will have to be devoted to planes, helicopters, trucks and supply lines than in "normal" disasters and relief efforts.
The Economist, "Asia's Devastation," January 1, 2005

7.1 Objectives of the survey

The intent of this survey was to collect data from organizations involved in Tsunami relief operations instead of relying on anecdotal accounts to identify supply chain issues and opportunities. These data were used to bring to light logistics problems and inefficiencies, determine the causes of these issues, and benchmark current practices. Results were shared with the relief logistics community in order to create plans for improvement and to enhance the design of future surveys.

7.2 Summary of Analysis

The Fritz Institute delivered the survey to 39 organizations actively participating in the Tsunami relief effort. The survey achieved a 47% response rate as 18 surveys were returned by April 8, 2005. Both headquarters and field operations staff completed the survey consolidating responses from several different people in the organization in order to provide a more complete picture of their supply chain activities. After collecting the surveys, the data were entered into a database at MIT and analyzed in partnership with the Fritz Institute. The comprehensive twenty-

two page survey was structured to obtain data from each area of the relief supply chain process detailed in Chapter 5. This chapter reports the results from each section of the survey below.

7.2.1 Preparedness

While most organizations (72%) said they have a process that enables them to create a plan for relief, few (38%) stated that their plan met their needs. The uniqueness of this particular disaster may have a strong impact on plan effectiveness. Indeed, 50% of organizations stated their original plans were not accurate. However, communication processes may also be an issue. Only 33% of the respondents confirmed that the plan of action was distributed according to established guidelines. Lacking accurate original plans hinders an organization's ability to follow established processes and move efficiently to the next steps of assessment, appeal, and resource mobilization.

7.2.2 Assessment and Appeal

Lack of information was a significant problem in accurately assessing the number and location of beneficiaries as well as the efforts of other programs operating in the area. Some of this can be attributed to the destruction of infrastructure inhibiting access and the fact that NGOs were previously denied the opportunity to work in areas with rebel forces. However, organizations failed to leverage knowledge from other organizations to compensate for the challenges in obtaining information. While 76% of the organizations in the survey conducted independent assessments, only 38% participated in both independent and joint assessments.

Another issue in assessment accuracy was the knowledge of the assessment staff. Only 38% of organizations had assessment team members from the area. Most of the teams consisted of international staff with little local knowledge. Further, while almost all of the respondents

reported using multi-disciplinary teams, only 58% included a logistician. The lack of local team members and trained logisticians only made it harder to collect useful information.

7.2.3 Resource Mobilization

Resource mobilization was divided into three separate categories: financial capabilities, human resources, and organizational set-up.

7.2.3.1 Financial Capabilities

Organizations commented on how well the financial aspect of their supply chains functioned. The majority of organizations were able to access necessary financial resources when needed. Only one response stated that necessary financial resources were not available when needed. The world's response was overwhelming and more than adequate to fund the Tsunami relief effort.

7.2.3.2 Human Resources

As mentioned in Section 8.2.2, there were not enough trained workers available. To address this issue, organizations employed several strategies to obtain trained staff. 88% of organizations brought in people from other operations. The same percentage pulled headquarters staff and sent them into the field. Both of these actions have a negative impact on the operations that lost those personnel. 72% used roster lists and 50% had standby mechanisms in place. As mentioned above, funding was not an issue. Therefore, most staffing needs could be met on a temporary basis with one to three month contracts that utilized funds designated for this effort. A small percentage of agreements lasted three to six months.

The availability of trained workers worsened as the organization moved closer to the disaster. Table 3 shows the average rating of human resources by region.

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	International	Regional	National	Area
Quality (specific expertise required)	4.5	3.7	3.8	2.9
Quantity (Adequate number)	3.4	2.9	3.3	2.9
Training (Trained to do specific tasks)	3.8	3.5	3.1	2.1

Table 3 Human Resources Ratings

Scale: 5=Excellent, 4=Good, 3=Average, 2=Needs Development, 1= Very Poor, and 0=None.

7.2.3.3 Organizational Set-up

Almost all of the responding organizations started new sites or hubs in the local area. 72% utilized an interagency coordination hub at some point in their relief effort indicating some level of cooperation.

7.2.4 Procurement

All respondents to the survey have established procurement procedures and used them for the Tsunami relief effort. Nevertheless, over half of the organizations experienced procurement delays. All organizations simultaneously chased the same items, resulting in shortages and delays.

Framework agreements are contracts with suppliers that set out terms and conditions under which specific purchases can be made throughout the term of the agreement. The survey revealed that utilization of framework agreements varied by the type of good. 56% of the organizations had framework agreements on non-food items and 50% for medical items. 70% of the organizations had these contracts with vehicle suppliers, given that vehicles are critical resources in the relief effort. Food supplies were generally not covered under pre-established

agreements. Perhaps this has to do with issues of spoilage, time to market, and a historical interest in purchasing food locally when possible.

Organizations perennially complain about unsolicited donations. The survey showed that unsolicited donations impacted the supply chains in different ways. Some types of donations were well received. For example, unsolicited vehicle donations received the possible highest rating. On the other hand, medical goods received the lowest usefulness rating on average. Once unsolicited goods arrived in impacted areas, the process of identifying the donation, prioritizing the items, and either transporting or storing the goods wasted valuable resources and negatively impacted the relief chain. However, if an organization had an established process to stop goods before they reached the local area, the donation of unsolicited items did not have a negative impact.

7.2.5 Transportation

The biggest issues affecting transportation were the extensive damage to infrastructure and customs delays. The Tsunami destroyed most coastal roads in Sumatra and Sri Lanka and damaged many of the vehicles. At first, many locations were accessible only by helicopters. 94% of the organizations encountered problems due to poor infrastructure. This caused congestion at the airports as local transport capacity was restricted to a few passable roads.

In deciding what transportation resources to use, organizations rated availability and time as the most important criteria, with compatibility and cost a distant second in priority (see Table 4). Given the high stakes of quick response, it is not a surprise that timeliness is the highest priority. However, prioritizing cost much lower than time may lead to a higher level of inefficiency than organizations prefer. Further, the private sector has found innovation by

considering a balanced objective of cost and service. It was also interesting how little impact political considerations seem to have on transportation decisions.

	Resources
Availability	4.65
Time	4.33
Compatibility	3.06
Cost	2.94
Political	1.83

Table 4 Transportation Resource Use Criteria

Survey respondents described customs as a bottleneck in both Indonesia and Sri Lanka. 71% of the respondents experienced delays. In both regions, radio equipment and medical supplies that could be used by rebel forces encountered longer delays. In general, the dynamic nature of customs procedures created problems. Immediately after the Tsunami, governments instituted open customs policies. Several weeks later, these policies changed but were poorly communicated and inconsistently applied. Eventually, UNJLC positioned a staff member at customs in Indonesia full-time to help with communication issues.

7.2.6 Track and Trace

Historically, humanitarian organizations have used ad-hoc solutions to handle track and trace functionality. The survey validated this observation. Only 26% of the respondents used software designed to track and trace goods through their supply chain. The remaining 74% used spreadsheets or manual processes. These methods do not capture metrics that could enable supply chain analysis. In spite of these less advanced systems, 58% of the organizations reported receiving accurate and timely updates on their pipeline information. This percentage has been challenged by interviews that indicate far less than half of the pipeline flow was communicated in a timely manner. Future surveys may need to gather more detail about pipeline visibility.

7.2.7 Stock Asset Management

The majority of organizations had both warehousing and inventory management systems and procedures in place and 85% answered that these systems and procedures met the needs of their operation. While these systems met their needs, the organizations deployed them in new locations. 71% reported that they did not use already existing regional logistics set-ups, thus obliging them to create novel local structures for this response.

Not all inventory was put into place after the Tsunami struck. Recent efforts have been made to strategically pre-position stock. In fact, the UNJLC is leading an initiative to establish the UN Humanitarian Response Network (UNHRN) of coordinated, strategically located stocks of emergency materials. A number of these depots managed by UN agencies and the Red Cross organizations are already independently in operation (Synthesis review of the UNJLC - 2nd draft report, unpublished document, March 20, 2005). In the survey, only the UN and Red Cross Movement affiliated organizations reported pre-positioned stock internationally and hardly any organizations pre-positioned stock at the regional and local levels. This is most likely because the pre-positioning of stock is counted as overhead for most NGOs. Interestingly, even with the attention from publicity of stock pre-positioning before this crisis, organizations assessed the performance of their pre-positioned stock rather poorly. By looking at the individual responses in Table 5, it is clear that pre-positioning occurs primarily at the international level with only modest success. At the regional level and below, pre-positioning is not common and when used not able to meet needs. Future work could determine why the pre-positioning did not perform better.

	Average	Individual Responses														
International	2.09	0	0	0	0	0	1	1	2	2	2	3	4	4	5	5	5
Regional	0.15	0	0	0	0	0	0	0	0	0	0	0	2				
National	0.80	0	0	0	0	0	0	0	0	1	1	1	2	2	2	3	
Area	0.31	0	0	0	0	0	0	0	0	0	0	0	2	2			

Table 5 Did Pre-positioned Stock Meet Your Needs?

Scale: 5=Yes, exceeded needs, 4=Yes, met all needs, 3=Yes, adequately met needs, 2=Yes, met some needs, 1=Yes, but did not meet needs, 0=No pre-positioned stock

7.2.8   Monitoring, Evaluating, and Reporting

All of the organizations have reporting mechanisms they employ to share information with headquarters and donors. These reports are primarily prepared by the finance organization and logistics teams are not usually involved in the process. The level of supply chain monitoring reported by organizations in this survey was not sophisticated. 73% of the responses indicated that their supply chain is measured solely by the time an order is placed to the time it is delivered. The private sector has far more emphasis on supply chain measurement. A table suggesting metrics for humanitarian logistics, based on an industry standard model (SCOR), is presented in Appendix C.

7.2.9   Communication

Cellular or satellite phones were used by 83% of the organizations in the first few days after the Tsunami. After a week, 50% of respondents were communicating by e-mail. Even though organizations were able to communicate relatively quickly, 87% of the organizations reported communication problems.

7.2.10 Collaboration and Coordination

Although collaboration with several types of organizations is very important in relief efforts, collaboration among humanitarian organization is still a challenge. While 77% of

organizations worked with local authorities, 69% worked with the military, and 77% worked with the private sector, only 56% worked with other agencies in setting up their supply chain. The survey indicates that collaboration experiences were positive. However, it seems that collaboration was done primarily on an ad hoc, "immediate needs" basis.

7.2.11 Final Thoughts

The survey left room for respondents to compose final thoughts. Representative samples of the comments are listed below:

- Give coordination of logistics to a central group (UNJLC) and let NGOs do the last mile, implementing as a partner.

- Coordination meetings in the beginning did result in better coordination

- In Sri Lanka, too many government agencies involved in one subject, it became a liability

- Limited air capacity with too many people

- Airport overworked and transport in short supply

- Delays in general because everyone in the same step of procurement which resulted in NGOs competing for the limited resources

7.3 Key Learnings

Following the devastating tsunami, public health experts warned of a possible second wave of deaths due to outbreaks of infectious diseases. They speculated that as many as 100,000 deaths would come from a secondary disaster of disease and hunger set to befall the survivors. Instead, the relief effort was effective as food, medicine, and other goods were delivered as fast as transportation could be arranged. The survey reflected the excellent logistics work done by

the humanitarian organization responding to the Tsunami, perhaps resulting from the strong financial response to this disaster.

The analysis showed that the issues organizations face are fundamentally common and not significantly influenced by organizational size. It also indicated that relief efforts need more attention on the following areas: assessment, collaboration, human resources, and supply chain analysis.

Assessment: Organizations responding to the survey were unable to specify accurately what was needed for the relief effort. Poor and damaged infrastructure, the lack of a pre-existing presence in separatist regions, and the limited availability of local and trained staff to perform the assessment negatively impacted the organizations ability to produce better-quality information from the affected areas.

Collaboration: After the Tsunami, relief organizations descended on the disaster zone. They fought to involve themselves in the relief effort, to save lives, and justify their existence to their donors. One survey respondent reported, "Relief assistance reached a saturation point in Banda Aceh." These competing supply chains caused bullwhip effects in procurement and congestion throughout the network. This competition reduced organizations' ability to maximize donations from the corporate sector and provide effective relief.

Coordination worked well for immediate needs, but was not being used for planning sustained needs. Inter-agency coordination hubs were used, but they could have been further utilized. More pre-disaster planning and quicker implementation could help utilization in the future. On a positive note, UNJLC's high quality website, logistics bulletins, and maps were valuable tools in coordinating logistics and operations.

Human resources: The scarcity of trained and experience logistics personnel led to significant organizational reassignments. With no local capacity or staff, organizations pulled logistics people from other programs and disasters. This possibly reduced the effectiveness of relief efforts that lost personnel. Further, organizations may have ineffective processes to develop logistics skills in local staff. The general lack of logistics expertise reduced organizations' capacity to implement their defined processes and led to more of an ad-hoc approach. The next chapter suggests some approaches to address this issue.

Supply Chain Analysis: Supply chain processes are in place, but they are primarily supported by manual or Excel-based systems. Relief organizations do no monitor the supply chain for operational improvement. Instead, donor-reporting requirements drive information collection. Once organizations understand the benefit of supply chain analysis, new information technology solutions, such as the Fritz Institute's HLS, can play a role to collect the necessary information and make reporting straightforward.

8 Recommendations For Future Research

"We don't need a donors' conference, we need a logistics conference."
A European Ambassador, New York Times, January 7, 2005

For its part, Doctors Without Borders, the American arm of the medical charity Médecins Sans Frontières, has told donors that it has already received as much money as it can spend at this stage. What is needed are supply-managers without borders: people to sort goods, identify priorities, track deliveries and direct the traffic of a relief effort in full gear.
The Economist.com (The Economist Global Agenda on January 5, 2005)

Using the 2004 South East Asia Earthquake and Tsunami as a focal point, this research investigated the relief supply chain and identified areas that hampered the relief effort. Issues that can be addressed in future research include lack of trained staff, poor coordination, and underutilization of metrics. Future research should investigate these areas as well as look at continuing relief logistics surveys, pre-positioning of stock, public / private partnerships, and donation earmarking.

Humanitarian logistics is not a formalized profession. There is no academic journal for relief logisticians or degree that credentials them. Field workers learn on the job. Unfortunately, the turnover rate is nearly 80 percent per year in humanitarian relief organizations (Haselkorn, 2005). Work needs to be done to professionalize the relief logistics sector. First, actors in this field must develop a widely accepted skill set that can guide development of education and certification programs. Education should be encouraged. University programs that prepare students for relief work, such as MIT, Harvard, and Tufts' Humanitarian Studies Initiative and the University of Washington's Interdisciplinary Program in Humanitarian Relief, should be

supported and emulated. Certification programs, such as those provided by Bioforce Development Institute and Red R, should be standardized and valued by relief organizations. The professionalization of the humanitarian logistics sector would help create a cadre of available logisticians with the skills essential in an emergency relief operation and reduce turnover by valuing professional logisticians.

Before the next big humanitarian crisis, research should investigate coordination. During the Tsunami, attempts were made to centralize the transportation process of different agencies by bigger organizations. In theory, it is an effective way to organize the vast amount of agencies and goods entering countries and to avoid congestion. However, in practice, joint strategic planning between agencies must take place before the event occurs. Command centers could be a part of this research. Command centers, whether local or international, are a focal point for managing an emergency, coordinating recovery programs, issuing information, and assembling personnel. Research could help to identify the optimal structure of emergency relief command centers.

Metrics are used extensively in the corporate world. Relief metrics are in their infancy (see Appendix C). Research could determine what should be measured and how metrics help operations. Once it clear what should be measured, humanitarian organizations will need to be educated in the value of supply chain monitoring and analysis - optimizing relief chains can save time, money, and lives. A successful implementation would involve a significant cultural shift. Fritz's HLS and the UN's Logistical Supply System (LSS) have the opportunity to capture this information and offer organizations the chance benefits from supply chain analysis. To increase the chance of adoption, the cost of ownership of these information systems should be reduced.

The work started by the Fritz Institute and analyzed in this study should be continued. Future surveys must be more focused. Relief workers in the field do not have time to complete a lengthy survey. Shorter surveys can be followed up with structured interviews to gain qualitative insights. These smaller surveys could focus on respondents at different levels within organizations. Each individual has a different viewpoint and responsibility. For example, a headquarters, point of entry, and field survey could be created. The results from this survey should be used to benchmark future disasters and track the development of the field over time.

One of the surprising findings from the survey was that pre-positioned stock did not perform well. Intuitively, an organization would expect pre-made, bought, and kitted supplies to perform better and faster. Future research could explore which items should be pre-positioned in which locations.

Public / private partnerships are an exciting area of research. One of the most successful examples of this is the Disaster Resource Network (DRN). DRN is a global network of companies committed to assisting humanitarian organizations in their efforts associated with disasters. DRN maintains a roster of committed firms and resources and matches resources to needs in the event of a disaster. In response to a request from the UNJLC, DRN Airport Emergency Teams (AET) were sent to Colombo, Sri Lanka and Banda Ache, Indonesia (*DRN team moves 6,000 tons of supplies*, n.d.). The AET team members are responsible for all supply stocks arriving by plane, including transport to warehouses and then on to delivery tucks.

It would be interesting to survey private companies, like DRN and TNT, which currently participate in these partnerships. Research could investigate effective relationships and seek to develop ways to increase the number of public / private partnerships.

Each disaster response should be better than the last. In order to improve humanitarian relief for the next disaster, work needs to be done to change the way that people view philanthropy. Giving money, earmarked solely for an immediate crisis makes little difference in an organization's efforts to respond to the next crisis. Funds need to be designated to develop insights and technology that apply across organizations. New process and technology infrastructure could support communication and coordination, assessment systems for early warning and response, knowledge systems to capture and apply lessons learned from previous efforts, and humanitarian logistics systems. Donors could also support strategic management, education, and research with the same approach.

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A Appendix A: Acronyms

AET	Airport Emergency Team
AMSAT	Radio Amateur Satellite Corporation
ARRL	American Radio Relay League
CMOC	Civil Military Operations Center
CRS	Catholic Relief Services
DFID	Department For International Development
DHA	UN Department of Humanitarian Affairs now known as OCHA
DRC	Disaster Research Center
DRN	Disaster Resource Network
EIS	Emergency Information Systems
EPIX	Emergency Preparedness Information Exchange
FEMA	Federal Emergency Management Agency
FEWS-NET	Famine Early Warning System Network
FTS	Financial Tracking Service
GAM	Free Aceh Movement
GIK	gifts-in-kind
GIS	Geographic Information Systems
HEWSweb	Humanitarian Early Warning Service
HLS	Humanitarian Logistics Software
HF	High Frequency
ICRC	International Committee of the Red Cross
IDP	Internally Displaced Person
IFRC	International Federation of the Red Cross
IMC	International Medical Corps
IOM	International Organization for Migration
IRC	International Rescue Committee
IRIN	Integrated Regional Information Networks
IT	information technology
LEO	Low Earth Orbit
LSS	Logistical Supply System
LTTE	Liberation Tigers of Tamil Eelam
MSF	Médecins Sans Frontières
NGO	Non Governmental Organizations
OCHA	UN Office for the Coordination of Humanitarian Affairs
OFDA	Office of US Foreign Disaster Assistance
PAHO	PanAmerican Health Organization
RFQ	Request for Quote
SAHIMS	Southern Africa Humanitarian Information Network
SMS	Short Message Service
TNI	Indonesian military forces

TPG	Royal TPG Post, the national postal operator in the Netherlands active worldwide
TRANSCOM	Transportation Command
TRO	Tamil Rehabilitation Organization
UN	United Nations
UNEP	UN Environmental Programme
UNHCR	UN High Commission for Refugees
UNHRN	UN Humanitarian Response Network
UNICEF	UN International Children's Emergency Fund
UNJLC	UN Joint Logistics Center
USAID	United States Agency for International Development
VAM	Vulnerability Analysis and Mapping
VHF	Very High Frequency
WFP	World Food Programme
WHO	World Health Organization
WVI	World Vision International
WWW	World Wide Web

B Appendix B: Sample Survey

Fritz Institute

Tsunami Relief Effectiveness Survey
Logistics

Name of Respondent: _____

Title/Position: _____

(Administrative, Relief worker, Volunteer, Expatriate, Local)

Responsibility: _____

(Please indicate whether part-time or full-time)

Organization: _____

(International, National, Regional, Local)

Location: _____

Date: _____

I. Preparedness

These questions focus on pre-established plans, not specific to this emergency.

1. Have you previously been involved in emergency relief operations?   **Yes/No/DK**

If yes, when did you first become engaged in providing emergency relief?

_____

_____

If yes, please complete the following. If no, proceed directly to Section II.

2. Did you have an existing process for developing your plan of action?   **Yes/No/DK**

3. Did you have an existing plan of action?   **Yes/No/DK**

4. Did you execute it for this emergency?   **Yes/No/DK/NA**

5. Was the plan of action distributed according to the guidelines established by your organization? **Yes/No/DK/NA**
   If yes, how?

   _____

   _____

6. Did your plan of action specify guidelines or directions for your job? **Yes/No/DK**
   If yes:

   a. What was it? _____

   b. What form did it take? _____

   c. When was it received? _____

   d. Was there any training? _____

7. Based on your assessment and initial operations did your plan of action fall short? **Yes/No/DK**
   If yes, please describe:

   _____

II. Assessment/Appeal

1. Did you conduct your assessment independently? **Yes/No/DK**

   If yes, please proceed to question #4.

2. Did your organization participate in a joint assessment? **Yes/No/DK**
   If yes, with whom? _____

3. Did you rely on others to conduct the assessment? **Yes/No/DK**
   If yes, whom? _____

4.

Please circle/highlight one answer:	Time after the Tsunami struck (12/26/04)				
When did the assessment team reach the affected area?	< 24 hours	24-72 hours	> one week	> two weeks	Don't know
When did you start to receive LOGISTICS information from the assessment team?	< 24 hours	24-72 hours	> one week	> two weeks	Don't know

5. Please indicate where your assessment team was from:

(circle all that apply)	International	Regional	National	Area
	Yes No DK	Yes No DK	Yes No DK	Yes No DK

6. Was your organization's assessment multidisciplinary   **Yes/No/DK**
   (i.e., logistics, medical, etc.)?
   If yes, please describe the disciplines represented:

   _____

   _____

7. Did the team have the capability to conduct the assessment in a timely manner? **Yes/No/DK**

8. Did the assessment enable you to develop your plan for this operation?   **Yes/No/DK**
   If yes, what information did you obtain?

   _____

   _____

   If no, what was missing?

   _____

   _____

9. When was the first appeal made?

Please circle one answer:	Time after the Tsunami struck (12/26/04)				
	< 24 hours	24-72 hours	> one week	> two weeks	Don't know

10. Did the appeal accurately reflect the needs on the ground?   **Yes/No/DK**
    If not, please explain:

   _____

   _____

III. Resource Mobilization

A. Financial Capabilities

1. Did you have the necessary financial resources available when you needed them? **Yes/No/DK**
   If no, how did it impede your progress?

   _____

   _____

2. Do you have the following procedures in place for managing your financial resources?

	Yes/No/ DK	If yes, please describe:
Control		
Monitori ng		
Distribut ion		

B. Human Resources

1.

Please circle one answer:	Time after the Tsunami struck (12/26/04)				
When do you think your teams were in place and operational?	< 24 hours	24-72 hours	> one week	> two weeks	Don't know

2. What mechanisms do you have in place to gain access to trained Human Resources?
   (Double click on box to check all that apply)
   ☐ Roster List ☐ Stand-by Mechanisms ☐ Other: _____

3. What is the average length of your contractor agreements? *(Check one)*
   ☐ 1-3 months ☐ 3-6 months ☐ 6-12 months ☐ Other: _____ ☐
   Don't Know

4. Did you encounter any procedural problems sending people?   **Yes/No/DK**
   If yes, please describe:

   _____

   _____

5. Please rate your human resources for this operation using the following scale.
   Scale: 5=Excellent, 4=Good, 3=Average, 2=Needs Development, 1=Very Poor,
   0=None, NA=Not Applicable

	International	Regional	National	Area
Quality (specific expertise required)				
Quantity (adequate number)				
Training (trained to do specific tasks)				

6. Were enough trained human resources available to you?   **Yes/No/DK**

7. Did you reinforce your headquarter team?   **Yes/No/DK**
   If yes, how many and when?

   _____

   _____

8. Did you call on people from other operations?   **Yes/No/DK**
   If yes, how many and when?

   _____

   _____

9. Did you send headquarter staff to the field operation?   **Yes/No/DK**
   If yes, how many and when?

   _____

   _____

C. Organizational Set-up

1. Describe how your operation is organized? (i.e., regional HQs, local sites, etc.)

	International	Regional	National	Area
Location(s)				
When was it operational? *(Please provide date)*				

2. Did you use interagency coordination hubs?   **Yes/No/DK**
   If yes:

   a. Which organizations? _____
   b. Where? _____
   c. When were they operational? _____

3. Did you need to establish <u>new</u> operations/sites in any of the following geographies?

	International	Regional	National	Area
(circle one)	Yes No DK	Yes No DK	Yes No DK	Yes No DK
Where?				
When were the site(s) operational? *(Please provide date)*				

4. Do you have a clear understanding of roles and responsibilities in your organization
   for this emergency?   **Yes/No/DK/NA**

IV. Procurement

1. Do you have established procurement procedures?   **Yes/No/DK**
   If yes, please describe: _____

2. Did you use them for this emergency?   **Yes/No/DK/NA**

3. Do you have framework agreements with suppliers for the following commodities?
Please indicate Yes/No/Don't Know in the boxes below.

Commodities	Yes/No/DK
Food	
Non-Food	
Medical	
Vehicles	
Other	

If yes, please describe:

_____

_____

4. Please estimate the <u>percentage</u> of commodities procured by geography.
   Where were these commodities procured? (i.e. what country, what city, etc.)

Commodities	International	Regional	National	Local	Where?
Food					
Non-Food					
Medical					
Vehicles					
Other:					

5. Did you have to procure non-standard kits?   **Yes/No/DK**
   If yes, please describe:

   a. <u>Which ones?</u>

   _____

   b. <u>Did you prepare them or did a supplier?</u>

   _____

6. For the supplies that were donated, what percentage was solicited vs. non-solicited?
   Indicate DK if don't know or N/A if not applicable.

	% of Total Donations	
Commodities	Solicited	Not Solicited
Food		
Non-Food		
Medical		
Vehicles		
Other		

7. Please answer the following regarding your organization's receipt and use of unsolicited goods and services, using the scale defined below. *Scale: 5=Accepted, improved the relief operation, 4=Accepted, used most/all, 3=Accepted, used some, 2=Accepted, but unable to use, 1=Accepted, but impeded the relief operation, 0=Received, but did not accept, N/A= Did not receive any goods or services.*

Food	Non-Food	Medical	Vehicles	Other *(please describe)*

Please describe the impact:

_____

_____

8. Did you experience any delays in the procurement process?   **Yes/No/DK**
   If yes, please estimate the impact: _____

9. Please answer the following regarding your organization's ability to procure (purchases and donations) adequate quantities of the following commodities using the following scale.
   Scale: 5=Excellent, 4=Good, 3=Average, 2=Needs Development, 1=Very Poor, 0 = None, NA=Not Applicable

	Food	Non-Food	Medical	Vehicles	Other
Did they meet the emergency response requirements?					
Did they meet your organizations specifications?					

Please comment:

_____

_____

10. Do you maintain purchase records and reports?   **Yes/No/DK**

11. How frequently do you update your records?

_____

_____

V. Transportation Execution

1. Please estimate which modes of transportation were utilized most frequently within each geography.

	International	Regional	National	Area
Air				
Sea				
Rail				
Road				
Other, please describe:				

Please comment on why:

_____

_____

2. Please rate the transportation modes utilized in terms of quality for each geographic area. Scale: 5=Excellent, 4=Good, 3=Average, 2=Needs Development, 1=Very Poor, 0 = None, NA=Not Applicable

	International	Regional	National	Area
Air				
Sea				
Rail				
Road				
Other				

Please comment on the quality, quantity, and timeliness:

_____

_____

3. In deciding who/what resources to use, please rank the following criteria in order of importance.
Rank: 5=most important, 1=least important

Availability	
Cost	
Time	
Compatibility	
Political	

4. Did you have problems with accessibility due to poor infrastructure (road, sea, etc.)? **Yes/No/DK**
   If yes, please describe:

   _____

   _____

5. Did you have problems with accessibility due to political barriers?   **Yes/No/DK**
   If yes, please describe:

   _____

   _____

6. Did you have any problems clearing customs?   **Yes/No/DK**
   If yes, please describe the nature of the problem:

   _____

   _____

   Please estimate the impact on time and money _____

7. Did you have access to fuel sources?   **Yes/No/DK**
   If yes, please describe: _____

8. Did you have access to generators?   **Yes/No/DK**
   If yes, please describe: _____

9. What transportation records and reports do you maintain? _____

   _____

10. How frequently do you update your records? _____

Air Transport

1. Please estimate the percentage of total air transportation utilized within each geography.
   Indicate DK if don't know or N/A if not applicable.

	International	Regional	National	Area
Commercial cargo				
Chartered aircraft				
Military assets				
Other organizations assets				

2. Was any of your air transportation donated?   **Yes/No/DK/NA**
   If yes, by whom? _____

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3. Please rate the following attributes for each type of air transportation.
    Scale: 5=Excellent, 4=Good, 3=Average, 2=Needs Development, 1=Very Poor, 0=None, NA=Not Applicable
    Indicate DK if don't know.

International	Commercial Cargo	Chartered Aircraft	Military Assets
Availability of space			
On-time			
Damage free			
Accessibility (infrastructure)			
Accessibility (political)			
Other working mechanisms *(i.e., paperwork, customs procedures, handling, etc.)*			

National	Commercial Cargo	Chartered Aircraft	Military Assets
Availability of space			
On-time			
Damage free			
Accessibility (infrastructure)			
Accessibility (political)			
Other working mechanisms *(i.e., paperwork, customs procedures, handling, etc.)*			

Area	Commercial Cargo	Chartered Aircraft	Military Assets
Availability of space			
On-time			
Damage free			
Accessibility (infrastructure)			
Accessibility (political)			
Other working mechanisms *(i.e., paperwork, customs procedures, handling, etc.)*			

Please indicate how your regional airlift operations were set-up, if applicable.

	Yes/No/DK	Which	Where	When
Used commercial companies				
Set up own operation				
Used inter-agencies operation set up				

	Yes/No/DK	Which	Where	When
Used military assets				
Use of other organizations' assets (not linked with inter-agencies set up)				

Which: Name of company, agency or organization
Where: Location in which utilized
When: Timeframe (i.e. 1ˢᵗ week, 1ˢᵗ month)

Comments: _____

5. For each airport utilized, please indicate the airport name, who is in charge of managing the goods at that airport (Yes/No) and rate the effectiveness of the relevant agency using the scale below.

   Scale: 5=Excellent, 4=Good, 3=Average, 2=Needs Development, 1=Very Poor, 0=None, NA=Not Applicable

	Airport Name(s)/Rating							
	Airport 1:		Airport 2:		Airport 3:		Airport 4:	
Local authorities								
Interagency set-up								
Military								
Other:								

EXAMPLE

	Airport Name(s)/Rating	
	Airport 1: Subang Airport	
Local authorities	Yes	5
Interagency set-up	No	NA
Military	No	NA
Other:	NA	NA

Sea Transport

1. Please indicate how your sea operations were set up.

	Yes/No/DK	Which	Where	When
Used commercial vessels				
Used chartered vessels				
Used military assets				

Use of other organizations' assets (not linked with inter-agencies set up)				

Which: Name of company, agency or organization
When: Timeframe (i.e. 1st week, 1st month) applicable.

Where: Location in which utilized
Indicate DK if don't know or N/A if not

Comments:

_____

_____

2. Please estimate the percentage of total sea transportation utilized within each geography.

	International	Regional	National	Area
Commercial vessels				
Chartered vessels				
Military assets				

Indicate DK if don't know or N/A if not applicable.

3. Please rate the following attributes for each type of sea transportation.
   Scale: 5=Excellent, 4=Good, 3=Average, 2=Needs Development, 1=Very Poor, 0=None

	Commercial Vessels	Chartered Vessels	Military Assets
Availability of Space			
On-time			
Damage free			
Accessibility (infrastructure)			
Accessibility (political)			
Other working mechanisms *(i.e. paperwork, customs procedures, handling, etc.)*			

Indicate DK if don't know or N/A if not applicable.

Comments:

_____

Road and Rail Transport

1. Please estimate the percentage of total road transportation utilized within each geography.

	International	Regional	National	Area
Commercial transporters				
Leased fleet				

Owned fleet				
Military assets				

Indicate DK if don't know or N/A if not applicable

2. Please rate the following attributes for each type of road transportation.
   Scale: 5=Excellent, 4=Good, 3=Average, 2=Needs Development, 1=Very Poor, 0=None

	Commercial Transport	Leased Fleet	Owned Fleet	Military Assets
Availability of space				
On-time				
Damage free				
Accessibility (infrastructure)				
Accessibility (political)				
Other working mechanisms *(i.e., paperwork, customs procedures, handling, etc.)*				

Indicate DK if don't know or N/A if not applicable.

Comments:
_____
_____

3. Do you have a fleet management system in place?   **Yes/No/DK**
   If yes, did it meet the needs of this operation?   **Yes/No/DK**
   Comments:
_____
_____

4. Did you use light vehicles?   **Yes/No/DK**
   If yes, where did you obtain them from?:

   a. Own fleet   **Yes/No/DK**
      b. Other operations   **Yes/No/DK**
      c. Rented   **Yes/No/DK**

5. If you used rail transportation, please answer the following:

   a. From where did the transport originate? _____
   b. What was the end destination(s)? _____
   c. When did you use rail transport? _____

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VI. Track and Trace

1. How did you track your goods and services?
   (check all the tools that apply)

	International	Regional	National	Area
Manually				
Excel spreadsheet				
Software/specify				
Other: (i.e. Bar-coding)				

2. What other forms of documentation do you maintain to track and trace your goods and services?

   _____

   _____

   _____

3. Did you receive timely and accurate information on pipeline?
   (i.e. what is coming, what needs to be dispatched, etc.)   **Yes/No/DK**
   If yes, please describe the system you have in place:

   _____

   _____

   _____

VII. Stock Asset Management (Warehousing)

1. Do you have warehousing systems and procedures?   **Yes/No/DK**
   If yes, did they meet the needs of this operation?   **Yes/No/DK**
   Comment:

   _____

   _____

2. Do you have inventory management systems and procedures?   **Yes/No/DK**
   If yes, did they meet the needs of this operation?   **Yes/No/DK**
   Comment:

   _____

   _____

3. How are your warehouse/stock locations organized? By:

   a. Central warehouse?   **Yes/No/DK**
   b. Regional hub?   **Yes/No/DK**
   c. Local storehouse?   **Yes/No/DK**

4. Do you have visibility into the stock that is available at your:

a. Central warehouse?	**Yes/No/DK**
b. Regional hub?	**Yes/No/DK**
c. Local storehouse?	**Yes/No/DK**

5. From where did you obtain stock?

a. Central warehouse?	**Yes/No/DK**
b. Regional hub?	**Yes/No/DK**
c. Local storehouse?	**Yes/No/DK**
d. Other agencies	**Yes/No/DK**
e. Other:	**Yes/No/DK**

6. How did you manage the information flow between the operation and stock locations?

_____

_____

7. Did you use already existing regional logistics set up?　　**Yes/No/DK**
   If yes:

   a. Where were they located? _____

   b. When did they become operational? _____

8. Did you have pre-positioned stock available in the following geographies and did they meet your needs?
   Scale: 5=Yes, exceeded needs, 4=Yes, met all needs, 3=Yes, adequately met needs, 2=Yes, met some needs, 1=Yes, but did not meet needs, 0=No pre-positioned stock

	Rate
International	
Regional	
National	
Area	

Indicate DK if don't know or N/A if not applicable.

Comments:

_____

_____

9. Did you share your local warehouse with other Agencies/NGOs?　　**Yes/No/DK**

10. How do you rate the following processes based on your experiences?
    Scale: 5=Excellent, 4=Good, 3=Average, 2=Needs Development, 1=Very Poor, 0=None

	Timeliness	Accuracy
Receiving		
Storing		
Dispatching		
Reporting		

Indicate DK if don't know or N/A if not applicable.

11. Did you find commercial warehouses in the areas of your operation?   **Yes/No/DK**

12. Do you have procedures that enable you to rent available warehouse space?   **Yes/No/DK**

13. Did you use warehouse tents?   **Yes/No/DK**
    If yes:

    a. Where? _____
    b. How many? _____
    c. When were they operational? _____
    d. Were they adequate? If not, why? _____

14. Did you have the following emergency relief items in stock?
    In the comments section, address issues related to lack of stock.

Commodities	Yes/No/DK	Comments
Food		
Vehicles		
Blankets		
Tarpaulins		
Tents		
Mosquito nets		
Jerry cans		
Kitchen sets		
Family parcels		
NEH kits		
Cholera kits		
Surgical kits		
Health units		
Watsan units		
Water purification tablets		

15. Please rate the quality of the following commodities as it relates to your response
    requirements:
    Scale: 5=Excellent, 4=Good, 3=Average, 2=Needs Development, 1=Very Poor, 0 = None

Commodities	Rating	Description
Food		
Non-Food		
Medical		

Vehicles		
Other		

Indicate DK if don't know or N/A if not applicable.

VIII. Monitoring/Evaluation/Reporting

1. Did you have a process for reporting your activities?　　　　　　　　**Yes/No/DK**
   If yes, to whom (headquarters, donors, other agencies, field operations, etc.)?

   _____

   _____

2. What metrics are you using to evaluate the effectiveness of your supply chain?

   _____

   _____

3. Was there an information management process to provide accountability to donors? **Yes/No/DK**
   If yes, please describe:

   _____

   _____

4. Overall, how do you rate the quantity, quality and timeliness of information used in managing
   your supply chain priorities?
   Scale: 5=Excellent, 4=Good, 3=Average, 2=Needs Development, 1=Very Poor, 0=None

Quantity	
Quality	
Timeliness	

Indicate DK if don't know or N/A if not applicable.

IX. Communication

For each mode of communication used in this operation, please indicate the timeframe in which each became operational:

Please circle/highlight one answer:	Time after the Tsunami struck (12/26/04)				
E-mail	< 24 hours	24-72 hours	> one week	> two weeks	Don't know
Cellular phone	< 24 hours	24-72 hours	> one week	> two weeks	Don't know
Satellite phone	< 24 hours	24-72 hours	> one week	> two weeks	Don't know
HF/VHF	< 24 hours	24-72 hours	> one week	> two weeks	Don't know

Indicate NA if not applicable.

2. Are your vehicles equipped with the following means of communications?
    If yes, please estimate the percentage of vehicles.

	Yes/No/DK	Estimated %
HF		
VHF		

3. Did you face any communication problems in the operation theater?   **Yes/No/DK**
    If yes, please describe?
    _____

    _____

X. Collaboration and Coordination

For questions 1-4 please indicate how you would rate the experience of working with each entity (use scale) where applicable.

1. Did you work with other agencies in setting up your supply chain?   **Yes/No/DK**
    If yes, please answer the questions below.
    Scale: 5=Excellent, 4=Good, 3=Average, 2=Needs Development, 1=Very Poor, 0 = None, NA=Not Applicable

Which agencies?	
When?	
For what purpose?	
Please rate your experience	

2. Did you work with the local authorities?   **Yes/No/DK**
    If yes, please answer the questions below:
    Scale: 5=Excellent, 4=Good, 3=Average, 2=Needs Development, 1=Very Poor, 0 = None, NA=Not Applicable

Which authorities?	
When?	
For what purpose?	
Please rate your experience	

3. Did you work with the military?   **Yes/No/DK**
    If yes, please answer the questions below:
    Scale: 5=Excellent, 4=Good, 3=Average, 2=Needs Development, 1=Very Poor, 0 = None, NA=Not Applicable

Which military?	

When?	
For what purpose?	
Please rate your experience	

4. Did you work with the private sector?   **Yes/No/DK**
   If yes, please answer the questions below:

Which companies/ organizations?	
When?	
For what purpose?	
Please rate your experience	

5. Did you utilize implementing partners (NGOs) in the area?   **Yes/No/DK**
   If yes, please describe:

Who	When	For what purpose?

6. How would you rate your experience of working with implementing partners (NGOs) in the area?

Who	When	Rate (comment)

Indicate DK if don't know or N/A if not applicable.

XI. Final Thoughts

Please provide your final thoughts on challenges and issues that were not covered during the interview.

_____

_____

_____

_____

C Appendix C: Metrics

SCOR Performance Attribute	Level 1 Metric	Humanitarian Metrics (Maria Rey)

Delivery Reliability	• Delivery performance
	• Fill rates
	• Perfect Order Fulfillment
		• Delivery times
		   o Central stock
		   o Beneficiaries
		• Fill rates
		• Perfect purchase order
		• Damage rates
		• Perfect shipment percentage
		   o Documentation accuracy

Responsiveness	• Order Fulfillment lead times	Velocity indicators
		Inbound
		• Requisition lead time
		• Purchase order lead time
		• Supplier lead time
		• Transit time
		• Customs clearance times
		• Local inbound transit times
		Central Stock
		• Days of inventory
		Outbound
		• Warehouse handling time
		   o Picking time
		   o Packing time
		   o Documentation time
		• Outbound cycle time
		• Distribution handling time

Flexibility	• Supply Chain response time • Production flexibility	• This is what you want in a disaster relief supply chain. No one really has a good handle on how to put numbers to this

Table 6 Customer Facing Metrics

SCOR Performance Attribute	Level 1 Metric	Humanitarian Metrics (Maria Rey)
Costs	- Cost of goods sold - Total supply chain management costs - Value-added productivity - Sales, general, and administrative cost (SGA) - Warranty / return processing costs	Inventory Costs - Annual inventory write-offs [perishables and obsolescence] - Shipping cost as % of value of goods - Warehousing cost as % of value of goods Procurement Costs - Procurement Savings [(commercial price – purchase price) / commercial price]
Asset Management Efficiency	- Cash-to-cash cycle time - Inventory days of supply - Asset turns	- Emergency Stock Turnover [Material Delivered / Material On-Hand] - Purchase Order per Person - Vehicle Capacity Utilization [km-Ton moved / total available capacity] - Metric Tons Shipped per person-hour [both central stock and field stock] - Space Utilization [occupied space / total available space]

Table 7 Internal Facing Metrics

SCOR Performance Attribute	Level 1 Metric	Humanitarian Metrics (Maria Rey)
Profitability	- Gross Margin - Operating Income - Net Income	Total Logistics Cost as % of Program Budget - Direct costs - Inventory carrying cost - Transportation cost - Warehousing cost - Indirect costs - Procurement admin - Headquarters overhead
Effectiveness of Return	Return on Assets	% of dollar to beneficiary % of dollar to overhead (overhead percentage)

Table 8 Accountability Metrics

SCOR	Humanitarian	
???	• Mortality rates	Context is important here. Normal rates will depend on the kind of disaster Flood/drought/famine/war/etc…
???	• Demand Accuracy (estimation)	
Need to measure metrics <u>AND</u> have a benchmark to use to evaluate your performance.	• Number of clients served • Percent of expenses spent on overhead or fundraising • Spending per client	Throughput more important during the relief phase of disaster response.
Metric Evaluation Criteria	• Caplice & Sheffi (1994) 1-4 interconnected 5-8 separate	1. validity 2. robustness 3. usefulness 4. integration 5. economy – benefit of tracking it outweighs the cost to collect 6. compatibility 7. level of detail 8. behavioral soundness
Metric System Evaluation	• Caplice & Sheffi (1995)	• Comprehensive • Causally oriented • Vertically integrated • Horizontally integrated • Internally comparable • useful

Table 9 Evaluation of Metrics