ABSTRACT

Recent natural disasters (e.g. hurricanes, earthquakes) and manmade crises (e.g. war, political disturbance) have highlighted the vulnerability of communities to unstable conditions. Reaching displaced people in crisis conditions depends on the effectiveness of the supply chain and its management systems. Hurricane Katrina’s impact on New Orleans (September 2005) highlighted weaknesses of supply chain systems rather than physical distribution shortcomings; the Kashmir earthquake (October 2005) highlighted problems of remoteness and physical capability to deliver aid. A number of models have been proposed (e.g. [1],[2]) to which most response systems or mechanisms broadly conform, but within these approaches wide variations can be identified. The authors of this paper have developed a model to accommodate the decision making process as well as the wide range of circumstances which, in practice, can impact on the workings of emergency supply chains. This paper represents an attempt to test the model against the conditions which prevailed in Thailand following the December 2004 Tsunami. This provides insights to the susceptibility of such supply chains to a wide range of pressures which can translate to sub-optimal solutions in terms of cargo routing, modes and methods employed, wastage rates, reliability of schedules, cost and other parameters.

KEY WORDS

Humanitarian Aid, Models, Asian Tsunami, Thailand

1. Introduction

The impact of natural disasters and man-made crises is often manifested in population instability; large-scale displacement of people (e.g. [3],[4]); water and food shortage; breakdown of services; infrastructure damage or destruction and inaccessibility due to transport disruption. There have been many major events in the recent past which have required a coordinated international response. These have included the Iran (Bam) earthquake (December 2003); the ongoing civil conflict in Sudan (2004 - present); the Indian Ocean Tsunami (December 2004) and the Kashmir earthquake (October 2005).

The provision of humanitarian aid and the logistics systems which deliver it differ from business logistics: such events often take place in less developed regions with inadequate infrastructure or where physical conditions severely limit the transport options [5]. In these situations sophisticated logistics techniques are difficult to implement: the consumer is not the customer of the carrier; logistics provision must often be coordinated between military and civilian organisations for which there may be little agreement on the status of the relationship (e.g. NGOs) and distribution networks must be established quickly in often politically difficult situations [6],[7],[8],[9],[10].

International emergency relief operations require the establishment and management of a supply chain. However, many aid organisations do not have adequate logistics systems or the processes to support the effective delivery of humanitarian aid. The logistics systems which enable the delivery of aid are generally part of a wider range of activities which include refugee protection, civil order restoration and aid security [11]. The problem is further complicated by a factors such as funding issues, employee turnover, weak use of technology and poor manual processes [12]. Often the understanding of supply chain management is weak, the systems are reactive rather than proactive, and performance improvement is neglected. While there are clear parallels between business logistics and relief logistics the latter remains relatively unsophisticated, although increased efforts are being made to understand the issues and develop systems which can improve the effectiveness of aid supply chains [13]. This paper therefore examines the emergency relief response processes for the Thailand component of the Asian Tsunami and discusses the general relationships between some of the participating bodies.
2. Humanitarian Aid Models

A number of models have been identified which incorporate many of the key stages of the emergency relief cycle and these are discussed in detail by Pettit and Beresford [14]. Carter’s Disaster Management Cycle details the continuum of inter-linked activities which comprise disaster and its management [1], while Haas et al illustrate the cycles of activity in a Recovery Model which identifies the overlaps between each of the phases of the full emergency relief cycle [2]. Pettit and Beresford [14] refined the Haas model to account for military involvement. In the early stages of a disaster or crisis this is often high, reflecting their capability to respond rapidly to severe needs. Non-military capability then gradually increases over time (Figure 1).

![Figure 1: A suggested model of Emergency Recovery](image)

A Disaster Response Model (DRM) was developed by Jennings et al [5], and further refined by Pettit and Beresford [14]. Its aim was: ‘to establish the common criteria which can be applied to all refugee crises with regard to the logistical processes by which food aid is transported and distributed’. Although each crisis is unique in its detail, most exhibits at least some similarities in the logistical response. The key stages of humanitarian aid supply are suggested by the Fritz Institute beginning with preparedness, then moving through a number of stages to the operational (transport and distribution) phase and then through further stages to a conclusion where performance is evaluated [12]. This sequence of events provides a clear starting point for integrating further ideas on humanitarian supply chains. As any situation develops through the three phases of preparedness, response and recovery, there will be a shift in the balance of effort being provided by the various organisations. In the early stages, if the military are involved, there will be a much greater level of effort provided by them. As time progresses, so this level of input will reduce as other humanitarian and development organisations gear up and increase their level of input (Figure 2).

![Figure 2: Changing Resource Balance Military / Non Military Aid Provision Over Time](image)

Clearly no simple model can represent all elements which might combine and the composite emergency relief response model [14] was an attempt to integrate the main components of emergency logistics response. The following assessment of the response in Thailand to the Tsunami presents an analysis of how this occurred.

3. Emergency Relief and Humanitarian Aid Response

3.1. The Disaster Management Cycle

Disaster management is “an applied science which seeks, by the systematic observation and analysis of disasters, to improve measures relating to prevention, mitigation, preparedness, emergency response and recovery” [2]. The three key elements: preparedness, response, and recovery cannot be designated to specific time periods, but all are consistently part of the preparation-reaction process [15]. The preparation phase of the disaster management cycle is reliant largely on pre-tested systems and communication (Table 1).
Response activities (Table 2) usually have to be carried out in crisis conditions and require flexible planning, organisation and disciplined training. As physical infrastructure such as roads, bridges and airports are commonly damaged by war or natural disaster, transport capacity is often severely limited [16]. Emergency relief is therefore heavily reliant on adapting conventional logistics capability to constrained circumstances.

### Table 1: Disaster Management - Preparation

<table>
<thead>
<tr>
<th>Disaster Policy</th>
<th>Involves governments and NGOs</th>
</tr>
</thead>
<tbody>
<tr>
<td>Organisational Structure</td>
<td>Clear and workable structures required for effective response.</td>
</tr>
<tr>
<td>Assessment of need</td>
<td>Accurate assessments of need required covering casualties, damage to infrastructure, crops, services, the national infrastructure and disease.</td>
</tr>
<tr>
<td>Planning</td>
<td>Preparedness measures should be set out in plans, devolving responsibilities and resources to appropriate groups or organisations.</td>
</tr>
<tr>
<td>Co-ordination</td>
<td>A system for is required for achieving co-ordinated effort.</td>
</tr>
<tr>
<td>Facilities and systems</td>
<td>Facilities for response operations, include communications, information technology, &amp; emergency relief arrangements as required.</td>
</tr>
<tr>
<td>Equipment and supplies</td>
<td>Designated and stockpiled where appropriate. Inventory Management</td>
</tr>
<tr>
<td>Training</td>
<td>Important for effective and adaptable response.</td>
</tr>
</tbody>
</table>

Source: Adapted from [2], [12], [14]

Recovery is a process "by which communities and the nation are assisted in returning to their proper level of functioning following a disaster" and can take many years [2]. The progression from response to recovery is gradual and the boundaries are usually blurred. Recovery programmes, like response activities, follow an evolutionary path and also have a major logistics component, summarised in Table 3. The response method and the time required to set up the aid supply chain will differ between man-made and natural crises [17]. Natural disasters may occur with little or no warning and they often necessitate very large-scale response at very short notice [18]. This was exemplified during the 2004 Asian tsunami crisis. A number of other factors relating to physical hindrances such as poor infrastructure, mountain barriers, remoteness or severe climatic conditions often further hamper the distribution of food aid by reducing the range of transport options available and by slowing down the movement [19].

### Table 3: Disaster Management – Recovery

<table>
<thead>
<tr>
<th>Logistics</th>
<th>Integrated into recovery programmes with increasing reliability.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Recovery programs and projects</td>
<td>Reduction in emergency projects and movement towards long-term development of diverse, integrated programs.</td>
</tr>
<tr>
<td>Decision-making and project implementation</td>
<td>Less emphasis on urgency. Move towards medium and long-term planning and project implementation.</td>
</tr>
<tr>
<td>Management of commodities and suppliers</td>
<td>Changing profile of commodities required and review of supplier and capacity requirements.</td>
</tr>
<tr>
<td>Maintenance of transport and transport systems</td>
<td>Ongoing improvement and development of transport infrastructure and systems oriented towards commercial criteria.</td>
</tr>
<tr>
<td>Personnel resources</td>
<td>Reduction in emergency personnel and movement towards development of skills required in the long-term</td>
</tr>
</tbody>
</table>

Source: Adapted from [2], [12], [14]

### 3.2. Aid Transport and Distribution

The logistics of transporting aid to an affected country is complex, involving a number of organisations and transport modes [5],[20],[21],[22]. Even before a crisis situation has arisen, the quality of the infrastructure of a potential host country, its topography and its political situation are all factors which can conspire against efficient logistical operations. In the case of landlocked countries, these problems make the logistics even more complex. Not only do the difficulties associated with the host country have to be addressed, but the conditions in the neighbouring countries through which the aid must travel must also be considered. The process of distributing food in such circumstances is especially difficult, and it is often necessary to engage military personnel and equipment to secure a route and establish a reliable supply chain, at least for an initial period [23],[24].

The aim of emergency logistics is to establish the transport pipeline tailored to fit a particular crisis. The principle leg of the pipeline is generally sea transport and ocean freight is generally the ‘driver’ of the supply chain in most cases. Currently the main choice of ocean freight is between vessel chartering or sending the freight via an existing scheduled liner service although a variety
of methods are likely to be used in order for aid to reach a crisis area very quickly. Tatham and Kovacs [25] discuss the possibility of using the sea-basing concept to enable a more rapid response in the early stages of a crisis [26]. Road transport is flexible, versatile, relatively inexpensive over short distances and the required infrastructure is usually available in most countries so road can normally provide a door-to-door service; it can also transport almost anything anywhere and at any time [27]. It does however have disadvantages as vehicles are susceptible to poor weather conditions and the available infrastructure may not be of a suitable quality [17],[22],[28]. Rail transport can carry large amounts of cargo cheaply and more quickly over long distances, but over short distances any advantage gained in time is generally consumed by the transfer of the cargo from road to rail. Additionally rail rarely offers a door-to-door service, meaning that road transport is needed first and last whenever rail is utilised [5]. The major disadvantage of rail transport is its fundamental inflexibility, its lack of gearing to commercial needs and, in the case of many countries, the basic lack of railway infrastructure [29]. Air freight is generally used in the early stages of an emergency or when the refugees are in an area inaccessible by any other mode of transport. However, the cost of air freight is far too high for most aid agencies to contemplate using over a long period of time [30]. It should also be noted that there are certain activities which the military may be better placed to provide and such activities include the transport of relief aid by either air or sea, the provision of air traffic control, airstrip or airport improvements and navigation aids, often in direct support of NGOs.

4 Disaster Management: The Asian (Thailand) Tsunami

4.1 Background

The Indian Ocean Tsunami of December 2004 affected all of the countries in, or fronting, the Indian Ocean including all East African nations, the west Indonesian Archipelago and the Malaysian peninsula. This event placed humanitarian aid provision under greater stresses than ever before, left more than 220,000 dead [31], many thousands unaccounted for and hundreds of thousands injured and/or at risk from disease. The aid operation had to provide aid over a vast geographical area where much of the infrastructure was either severely damaged or totally destroyed. Aid provision had to be coordinated on an unprecedented scale amongst a number of Governments and a wide range of NGOs, UN bodies, ICRC and Military players. In this case, the scale of the disaster has been so large that in the early stages of the crisis it was only possible to get aid to the worst affected areas with the use of military resources. In the Banda Aceh region of Indonesia, for example, it was reported that around 400 separate organisations were working in the region, providing a broad range of humanitarian assistance. These included UN relief agencies, NGOs, government agencies, military groups and private companies. One of the biggest problems with a disaster on such a scale was undoubtedly a lack of preparedness. It was notable that the main need in Sri Lanka, India, Thailand, the Maldives and Malaysia was for clean water, food and medical supplies. The initial surge of donations, however, was largely of clothing.

4.2. Master Plan for Hazard Evacuation, Pre-Tsunami

The Asian Tsunami created an unprecedented humanitarian crisis for which there was no preparedness [32]. Perhaps the clearest illustration of the lack of preparedness on the part of the Thai government for a Tsunami-related emergency is illustrated by the structure and brief of the Department of Disaster Prevention and Mitigation, Ministry of Interior (DDPMMI) prior to the Tsunami occurring. In the Master Plan for Flood, Windstorm and Mudslide Hazards Prevention published in 2005 [33] but compiled prior to the Tsunami, there is no mention and therefore no strategy for Tsunami contingency planning or response. Emphasis throughout the document is understandably on the study and hazard evaluation process for floods, windstorms and mudslide which historically have impacted the country from time to time, especially in specific seasons. Statistics for windstorms, for instance, indicate that there were 12,623 events from 1997 to 2003 (averaging 1,803 per annum), causing 283 deaths during that period. The windstorm prone areas are well documented as, in the main, tropical cyclone paths are reasonably predictable. The risk level for each area of Thailand is categorised as low, moderate or high. Similarly accurate statistics for floods are also maintained and from 1997 to 2004 there were 84 separate flood events resulting in 811 deaths. The map of Thailand’s flood prone areas, again split into three risk categories (low, medium and high risk) is very detailed and provides a good level of preparedness overall for local communities. In the case of mudslides, it is interesting to note that frequency for events was very low (1 to 2 events per annum, 1970 to 2001) but then rose steeply from 2001 to 2004 before falling back in 2005. A survey undertaken by DDPMMI ascertained that the key organisations involved should have integrated short and long term disaster prevention plans, disaster warning systems should be installed, the whole data system should be linked, there should be detailed mapping of disaster prone areas and evacuation areas. Specific problems relating to central organisations and associations were identified as: lack of knowledge and experience in large scale disaster management, duplicated work amongst agencies, inadequate database and network systems and,
unclear communication and decision making systems in some areas. At a more local level problems include telecommunication inadequacies including and cell-phone networks, some shortages of rescue equipment, disaster warning systems do not cover all areas, more disaster drills required, shortage of trained personnel and finance. Thus, although there was a clear structure for disaster response, in these reports there was a complete absence of reference to the Tsunami hazard and by implication there was thus a complete lack of preparedness for a Tsunami type event [33].

4.3. Preparedness for Tsunami Events

The December 2004 Tsunami event prompted a major review of preparation plans, evacuation procedures and future planning contingency measures. Specifically, the Master Plan for Tsunami Evacuation [34] is covered by two Acts (Civil Defense Act, Building Control Act) and two plans (Civil Defense Plan, National Preparedness Plan). In summary the areas which have been identified as vulnerable to the Tsunami hazard consist of coastal Thailand fronting the Andaman Sea, and all islands and island groups in the six southern provinces of Ranong, Phang-Na, Phuket, Krabi, Trang and Satun. The vulnerable areas are split into sub-districts and villages as shown in Table 4.

Table 4: Tsunami Susceptible Areas in Thailand

<table>
<thead>
<tr>
<th>Province</th>
<th>Total</th>
<th>Sub-district</th>
<th>Villages</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ranong</td>
<td>2 Districts</td>
<td>1 Branch District</td>
<td>10</td>
</tr>
<tr>
<td>Phang-Na</td>
<td>6 Districts</td>
<td>19</td>
<td>69</td>
</tr>
<tr>
<td>Phuket</td>
<td>3 Districts</td>
<td>14</td>
<td>63</td>
</tr>
<tr>
<td>Krabi</td>
<td>5 Districts</td>
<td>22</td>
<td>112</td>
</tr>
<tr>
<td>Trang</td>
<td>3 Districts</td>
<td>1 Branch District</td>
<td>13</td>
</tr>
<tr>
<td>Sutan</td>
<td>4 Districts</td>
<td>17</td>
<td>70</td>
</tr>
<tr>
<td>6 Provinces</td>
<td>23 Districts</td>
<td>2 Branch Districts</td>
<td>95</td>
</tr>
</tbody>
</table>

Source: [34]

Under the Master Plan, the Regional Civil Defence Directing Center (RCDDC) is tasked to direct, control administer and provide recommendations about Tsunami prevention and mitigation. Within its remit transport and logistics support are implicit rather than explicit. Emphasis is mainly on evacuation, communications and victim support. Paragraph 4.3.3.7, however, does refer to distribution of aid materials to disaster victims, referring mainly to supplies, temporary shelter and health / welfare materials.

Consistent with other approaches e.g. [1] the Master Plan for Tsunami Evacuation highlights three main phases: Pre-disaster; During disaster and Post Tsunami. The pre-disaster phase has highlighted all communities at risk to heighten individuals awareness of the procedures which need to be adopted in the event of a Tsunami occurring. Specifically the preparations involve identifying safe areas for evacuation, main and alternative evacuation routes, signage and maps showing these routes, emergency support units and the provision of vehicles, tools and hazard related equipment. The dissemination of Tsunami warnings is in the first instance from two types of warning towers – the first type is maintained and monitored by the Royal Thai Navy – the second type is an automatic unmanned warning system, which have been installed along the beaches in the six provinces bordering the Andaman Sea. Immediately backing up these initial warnings is an Amateur Radio Network which disseminates warning information from 76 Control Stations (one in each province) via an Echolink System and normal frequencies in the amateur radio network to provincial users of these networks.

4.4 During Tsunami Response

Here, emphasis is on clarity of responsibility and communications networks. Regarding the evacuation of people there is an order of priority and all villages must have arrangements for evacuation to safe areas either outside the zone affected by the December 2004 Tsunami or on land higher than 15 metres above sea-level. These safe areas must be identified, advertised and signed. Specifically, under the evacuation of people section transport routes, vehicles fuel supplies and communication equipment are cited as key requirements. Similarly, main and alternative evacuation routes are identified so that all communities have at least two routes to safety. Learning from the experience of the December 2004 Tsunami the Thai government has recognised the importance of an effective telecommunications network which can support both the evacuation procedures and any post-Tsunami provision of aid and effective logistics operations [34].

4.5. Post Tsunami Phase

Assuming that a Tsunami alert is cancelled then the resident population will be able, very quickly, to return to their property. Nominated leaders of communities or villages will lead the systematic return in close cooperation with evacuation officials. Where appropriate the ACDDC must itself coordinate with military units, governments agencies, private companies (such a transport companies) and other organizations according to need. Overseeing the three phases is the National Disaster Warning Centre which must be operational 24 hours a day regardless of whether an emergency situation is prevailing or not.
A lesson learned from previous emergency responses in the area of information and emergency telecommunications is the importance of providing timely and relevant information about relief operations to local, national and international audiences. Communications with those affected by the disaster are often neglected. Two main objectives are establish communications networks for new offices to facilitate relief operations ensuring that there is data and system connectivity to support humanitarian operations and secondly to harmonise activities between the humanitarian community and government counterparts to ensure effective communications and the maximum utilisation of resources [35].

Although there is little specific reference to logistics requirements in the Master Plan for Tsunami Evacuation, effective transport of people away from danger, supplies to displaced people and overall mobility to respond to rapidly changing circumstances clearly implies that effective logistics systems are at the centre of any emergency contingency plan. Examples of specific bodies which have on the ground experience are the World Food Programme (WFP) and the International Organisation for Migration (IOM). In Indonesia they provided transportation, storage, communication and coordination support for the distribution of aid to affected areas. WFP acted as the lead agency for the logistics cluster within the National Disaster Managing Board Secretariat. Activities included organising the land fleet departing from Jakarta (one convoy – twenty trucks) and five convoys departing from Medan (twenty trucks), storage of relief goods, and relief item procurement and application [35]. By tracking events immediately following the Tsunami event in Thailand a simplified view of the response processes can be determined and this is presented in Figure 3.

5. Conclusions

The December 2004 Tsunami disaster, unprecedented in its scale and reach, offered an opportunity to examine the workings of aid logistics in extreme conditions. The most obvious feature of the response sequence is the lack of preparedness which existed in most of the affected countries at the time. The subsequent reaction of the Thai government, local people, aid agencies and other relevant bodies was approximately what would be expected from the models shown in Figures 1 and 2. The other important feature in the Thailand case is the development of an additional emergency Masterplan developed as contingency for possible future Tsunami events. It is interesting to observe that within the response mechanisms reported on the ground and as formalised in the Masterplan, relatively little emphasis is placed on transport or logistics; rather these crucial areas are implicit not explicit. This is consistent with the view presented in the existing body of literature which also tends to underemphasise the role of logistics in emergency conditions [14]. However, it is clear that there is no single model which can accommodate all the variables in the supply of emergency relief materials.

Fresh research initiatives have emerged in the last two years or so. These include the Humanitarian and Emergency Logistics Professionals (HELP) Forum in the UK. This is an initiative based on work undertaken by members of the Chartered Institute of Logistics and Transport who together offer expertise in the relevant areas of logistics practices in crisis conditions (Kovacs and Spens, 2007). In the academic field various initiatives exist including the Cardiff Cranfield Humanitarian Initiative (CCHIL) (UK) and the Humanitarian Logistics Project (HUMLOG) (Scandinavia).

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