Int. J. Production Economics 145 (2013) 613–629

Contents lists available at ScienceDirect

Int. J. Production Economics

journal homepage: www.elsevier.com/locate/ijpe

Before and after disaster strikes: A relief supply chain decision support framework

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ARTICLE INFO

Article history:
Received 27 September 2012
Accepted 18 May 2013
Available online 28 May 2013

Keywords:
Disaster preparedness
Communication
Failure mode effects and critical analysis (FMECA)
Authority structure
Relief supply chain
Social media

ABSTRACT

The potential and scope of damages resulting from large scale natural disasters is undisputed. Additionally, the risks that societies are facing continue to grow along with the global population. A decision support risk assessment and mitigation framework for disaster relief supply chain is proposed. This framework was applied to the example of the March 2011 disaster in Japan which was the result of a Tsunami, after a strong earthquake, followed by flooding and meltdown of multiple nuclear reactors. The evidence of relief supply chain effectiveness is examined and diagnosed in specific instances when the supply chain has failed to perform. Key stages are identified within the relief supply chain, and these stages are connected through communication and collaboration. By identifying and quantifying different risks under different stages in the supply chain using fault tree analysis and then imputing them into the model, the results are helpful in the decision making process. The failure mode effects and critical analysis method was used to assess the reliability of a relief supply chain system and its critical components. The research suggests the support for a network authority for utilizing diverse expertise for organizing the efficient relief supply chain. This structure makes use of the community relationships and trust that NGOs have built in areas throughout the world to aid in crises. The development of a robust communications plan and system will help coordination of all groups, prior to, during, and after a disaster, and will provide a more effective response.

1. Introduction

On March 11, 2011, an earthquake off the Pacific coast of the Tohoku region of Japan caused a series of disasters across the island. Citizens and authorities were aware of the fundamental risk of a catastrophic Tsunami. However, the preparations were inadequate to deal with this disaster. The disaster had three major events. The first event was the earthquake which caused structural damage and damage to the infrastructure of the affected region. Shortly after the earthquake, a Tsunami wave rushed ashore causing further severe devastation. As a result of this Tsunami, several of the back-up systems in the Fukushima Nuclear plant, responsible for maintaining the cooling system failed, which resulted in several explosions and the eventual complete meltdown of all three reactor cores.

This study will evaluate how well societal and infrastructure systems were functioning prior, during, and after this disaster. The safety nets that society expect to be in place are not always present or properly set up to maximize effectiveness in the event of a large scale disaster. The response by the Japanese government and other NGO aid groups was inadequate for the scope of this disaster, yet the risk of such a disaster should not have been completely unforeseeable. In natural disasters such as this, communication between all of the different entities involved in the disaster response is absolutely critical. Unfortunately, failure in communication is frequent, and potentially catastrophic. In order for governments and organizations to be better prepared for such disasters it is important that they understand how the failures in Japan occurred and what framework might ameliorate a disaster relief problem of this magnitude. The Japanese government knew, or should have known, about the possibility of a large Tsunami hitting their coast and should have had better disaster preparedness programs. According to some researchers such as Michel-Kerjan and Slovic (2010); Benjamin et al. (2011); Zook et al. (2010) the earthquake in Haiti for example was just a hint of what may be expected in the future. These researchers point out the fact that the planet's number of disasters shown in Fig. 1a and 40 costliest catastrophes have occurred since 1970 shown in Fig. 1b, due to: (1) a world population that is quickly growing; (2) a larger concentration of assets (and people) in high-risk areas; and (3) increasing social and economic interdependency. The devastation in Haiti, along with the frustration with the delays in receiving aid, congestion and suffering underscore the need for more research on disaster relief supply chain management according to Whybark et al. (2010).

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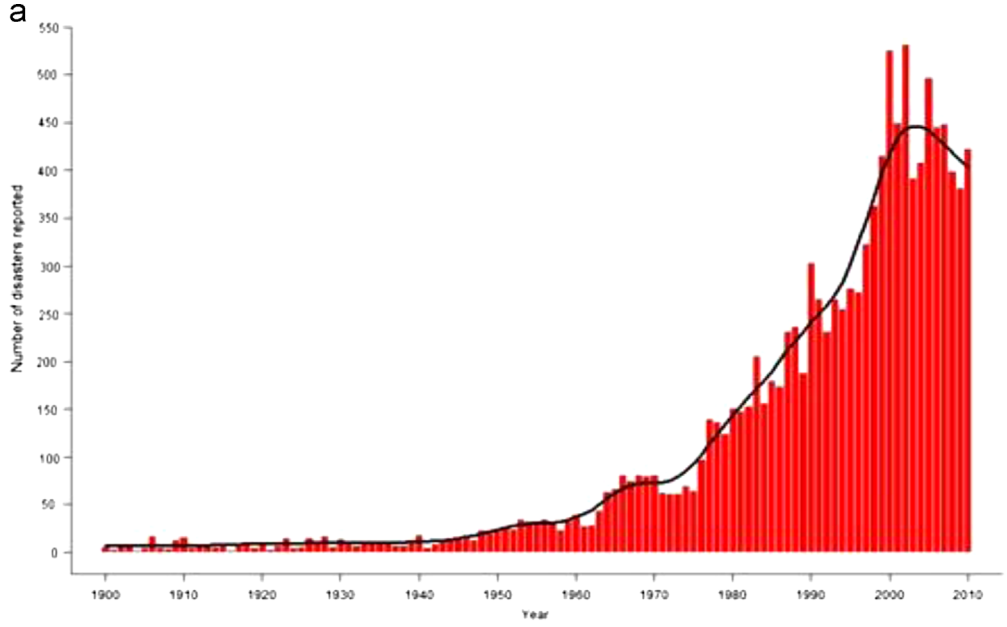
http://dx.doi.org/10.1016/j.ijpe.2013.05.016

a



Year	1900	1910	1920	1930	1940	1950	1960	1970	1980	1990	2000	2010
Number of disasters	5	5	8	10	15	30	45	65	120	250	450	400

b

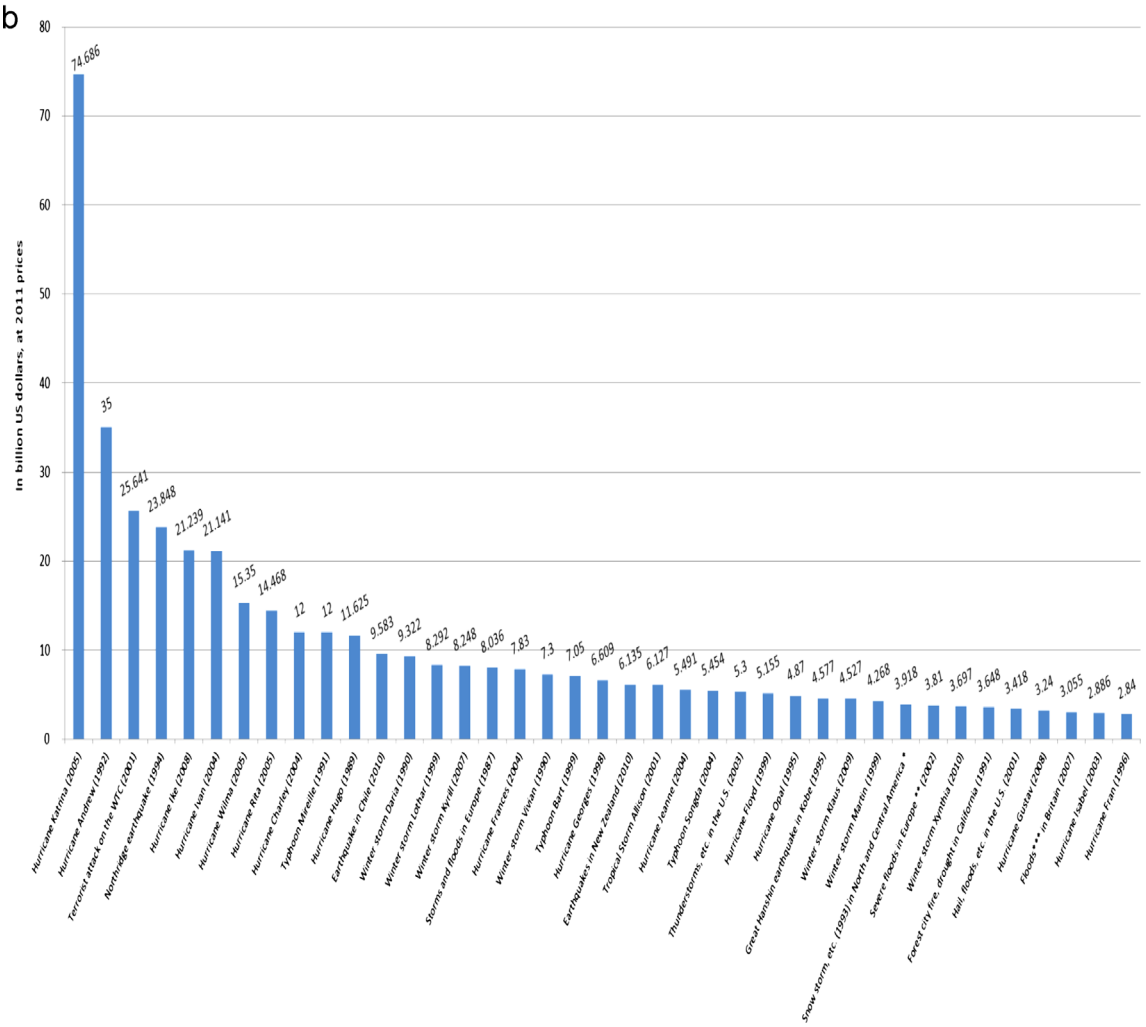


Fig. 1. (a) Natural disasters reported during 1900–2011 and (b) 40 most expensive insured losses between 1970 and 2011.
Source: Natural Disaster Trends, 2011.