

# **A Review on Main Challenges of Disaster Relief Supply Chain to Reduce Casualties in Case of Natural Disasters**

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## **Abstract**

Iran is among the ten disaster-prone countries and, in terms of the earthquake, it has been ranked the sixth in the world. Although the damages caused by the disasters are not irreversible from different aspects, they could be reduced to the minimum by choosing appropriate preventive actions as well as preparedness plans to counteract the impacts of these incidents. According to the increasing trend of disasters and crises which destroy businesses and communities, considering relief supply chain under crisis situations (HDRSC), in the wide field of supply chain management (SCM), is necessary and vital. Even though the considerable volume of research have been done in the field of supply chain and with the focus on the disaster relief, few studies have addressed its complex features and properties. So, this paper concentrates on the activities such as demand determination and supply chain coordination. This research provides the supply chain managers who are faced with similar problems in other environments with valuable insights .

**Keywords:** Disaster Relief Supply Chain, Logistic, Disaster Relief,

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Management, Relief.

## **Introduction**

Nowadays, despite of technological advances, one of the main barriers to the countries' sustainable development is suffering from natural disasters (earthquake, flood, storm, lightning, avalanche, tornado, fire, volcanic burst and etc.) as well as unnatural ones (war, terrorist attacks, road accidents, industrial accidents, political issues, immigration, homelessness and etc.) and unpreparedness and inappropriate confrontation against these disasters impose heavy damages and losses to nations and their properties which might sometimes be irrecoverable.

What happens in a part of the world, influences on the other parts' activities. When disasters and crisis take place continuously in a part of today's world, their economic, social and emotional effects is not limited to the part facing them directly only, but their second and third order effects remain in the form of the wave in supply chains all over the world. In 27<sup>th</sup> of August 1883, explosion and eruption in Krakatoa, Indonesia left 100000 dead behind and the explosion had been heard from 3000 miles away. Weeks later people in Australia, Netherland, Berlin and New York realized the real details of this disaster (BEAMON, 2004). On Friday 11<sup>th</sup> of March 2011, east coasts of Japan were destroyed by Tohoku earthquake and tsunami. Many people around the world watched this disaster live. Therefore, disasters and crisis generate influences needing immediate action aiming reduction of these effects (social, humanitarian and economic) and speeding up the recovery process. In the heart of these challenges lays HDRSC (Humanitarian disaster relief supply chain).

According to investigations, Iran is among the first ten disaster-prone and the sixth earthquake-prone countries of the world. Random and unpredictable nature of natural disasters (especially earthquake) requires designing thorough crisis

management plans in order to reduce the risks and alleviate the sufferings caused by the crisis. In fact, the main purpose of relief responses and reactions is better planning for encountering these types of phenomena and increasing public awareness to be able to decrease death and injuries as well as reducing property loss (Bozorgi-Amiri, Jabalameli, & Al-E-Hashem, 2013).

Among natural disasters, three specific ones- earthquake, flood and drought- cause the most damages in Iran. According to the international institute of seismology and earthquake engineering, nearly 83% of the population in Iran live in areas with relatively much danger of earthquake and 51% are subjected to flood. Deadly earthquakes in Iran are due to the fact that Iran is located on one of the two large seismic belts in the world known as Alpa as well as existing numerous faults in Iran plateau.

On the other hand, based on geological studies, it would not be beyond expectation for occurring at least one deadly earthquake in Tehran every 151 years. In accordance with the last earthquake in Tehran (with larger than 7 in Richter scale) which occurred 168 years ago as well as several crucial faults located around Tehran, one could expect the possibility of a deadly earthquake every moment in Tehran district. This problem together with Tehran condition from different aspects of unprincipled structures, population concentration, political-cultural concentration and probable damages in water, electricity and gas lines after earthquake would lead Tehran earthquake to being deadlier; the way that, based on existing reports, it will be considered as one of the largest disasters of the world from humanitarian and financial losses point of view.

Since wideness and intensity of natural disasters are increasing due to reasons, like population growth, climate changes, and global integration, it is predicted that current aids would be insufficient. On the other hand, nature of natural disasters is the way that responding to them should be carried out in a short time. In such

urgent and complicated situations, the decider should quickly and effectively respond to logistic problems and transfer suffered people from damaged areas to specified center; where this will not also be possible without precise planning and systematic relief network.

Although damages caused by these accidents will not be recoverable, especially financially and mentally, but with predictive actions and appropriate plans for being well prepared to encounter these disasters, the damages could be reduced to the minimum. Since intensity and wideness of these accidents are large, the produced volume of request for aid and rescue operation would also be large after occurrence and aid centers, which are able to supply the city needs in normal situations, are often insufficient for quick respond to the produced requests in these situations.

Furthermore, it would be worth noticing that dealing with victims, transporting necessary items, offering medical first aids and transferring the injured to relief centers in suitable time, specifically the first 72 hours after the disaster (the golden relief time) have important role in reduction of loss and disabilities caused by these accidents (Jang, Lien & Tsal, 2009).

Therefore, the main necessity is the difference between crisis and normal conditions. One of the important actions necessary to be conducted in the case of the crisis is to optimize the distribution and assignment of resources among people. Time has the crucial influence on increasing number of rescued people by relief activities. Since precisely determining the demand for critical items in case of disasters, among which medicine is the most important one, is indeed difficult and impossible in many situations, this adds up the difficulty of the problem. In fact, the main difference between the problem in crisis and in the normal situation is the severe uncertainty and time limitation in helping the victims.

This paper introduces the opportunities and importance of crisis supply chain. It

has been attempted to detect what distinguishes the crisis supply chain. In the case of crisis, many things are in danger the most critical of which is the staff lives. Designing, implementing and managing the crisis supply chain, and especially its logistic, one could not only reduce the costs but also it could save more lives.

### **An Introduction to Supply Chain Management (SCM)**

A supply chain includes all stages that, directly or indirectly, play roles in meeting a customer's demand. In an ordinary supply chain, raw materials are sent by providers to factories and, then, the products produced in the factories are delivered to central warehouses and distributor ones and, from there, they are transferred to retailers and, eventually, are delivered to the final customer which is the consumer. Thereby, an article passes through different stages of the chain to reach to the consumer. In some stages, the article is stored and in others, it is shipped. The Supply chain members are generally as following:

Providers, Stocks of raw materials, Distribution centers, Distributors, Retailers and Final customer.

Figure (1) shows the schematic of a supply chain:



**Figure (1): General structure of a supply chain**

Activities of the supply chain start with the customer order and end when the

customer pays the expenses of received article and service and the final product is delivered to him. The difference between the money spent by the customer with total costs spent by the whole chain to produce and distribute the article shows the chain profitability. Accordingly, the success of a chain is defined by its profitability and the supply chain management requires managing the flows between the stages and inside each of the stages of the chain in order to maximize the total profit. Thereby, supply chain management would be definable as below:

A set of guidelines for integration of the chain members (providers, producers, distributors, retailers and final customer) whose purpose is to reduce the system costs and to increase the level of service to customers (Yi & Özdamar, 2007). From this definition two following points would be comprehended:

First, the supply chain management pays attention to any approach that leads to the reduction of costs and plays a role in meeting the customer's need, from provider and production facilities to raw material stocks of distribution centers as well as retailers and products stock. In fact, in some supply chain analysis, it would be essential to focus on providers and customers, because they have the critical role in the formation of the supply chain.

Second, the supply chain management means increasing effectivity as well as reducing costs within the whole system. Employing the well-known approaches in supply chain management, the total cost of the system, including transportation costs, stock, material handling and etc., would be decreased. However, this does not emphasize that transportation, stocks and other costs will be reduced only, but, using a systematic approach, the supply chain management attempts to improve the whole system efficiency and level up serving the customer as well.

Since supply chain management emphasizes on integration between providers, distributors, and final customer, it covers most of the company activities in

different levels, from strategic levels to tactical and operational ones.

Main barriers for integrating the supply chain are as following:

- 1- It is possible that different members of the supply chain have different and incompatible goals. For instance, the providers would usually want the producers to buy a large amount of article with constant volume and flexible delivery date from them. However, the producers are supposed to be flexible with respect to the customer need as well as changes in the demand, because the production decisions are often made without exact information about the demand.
- 2- The capability of producers in adopting supply with demand is highly dependent on their ability to change the size of order lot and, for this reason, they are willing to buy in smaller lot-sizes and with variable volume. Similarly, the purpose of producers in productions with high volumes is usually in contrast with the target of distributors and shopping centers, because they always want to reduce their stock and increase their order frequency which could lead to an incline in transportation costs. At the end of the chain, i.e. from the customer side, when a change is induced in the demand, all members of the chain should change themselves with respect to it, but a lot of time is required to have this change applied to all levels of the chain, because this change accompanies a time delay. The main problem is this fluctuation in demand gets more intense when approaching the beginning of the chain. This phenomenon is called Bullwhip effect in the supply chain (Yi & Özdamar, 2007).

### **Disaster Relief**

The term “disaster” is usually applied to a breakdown in the normal functioning of a community that has a significant adverse impact on people, their works, and

their environment, overwhelming local response capacity. This situation may be the result of a natural event such as a hurricane or earthquake; or it may be the result of human activities (PAHO 2001).

Some organizations make a distinction between “disasters” the result of natural phenomena and “complex emergencies” that are the product of armed conflicts or large-scale violence and often lead to massive displacements of people, famine, and outflows of refugees. A disaster, as defined by the World Health Organization (WHO), is any occurrence that causes damage, destruction, ecological disruption, loss of human life, human suffering, deterioration of health and health services on a scale sufficient to warrant an extraordinary response from outside the affected community or area (Haghani,2009).

The American Red Cross defines a disaster as an occurrence or situation that causes human suffering or creates human needs that the victims cannot alleviate without assistance. Earthquakes, hurricanes, tornadoes, volcanic eruptions, wild fires, floods, blizzard, drought, terrorism, chemical spills and nuclear accidents are included among the causes of disasters, and all have significant devastating effects in terms of human injuries and property damage.

Alexander (1999) defines natural disaster as some rapid, instantaneous or profound impact of the natural environment upon the socio-economic system. He also recommends Turner’s (1976) definition of natural disaster as “an event, concentrated in time and space, which threatens a society or subdivision of a society with major unwanted consequences as a result of the collapse of precautions which had previously been culturally accepted as adequate”.

Center for Research on the Epidemiology of Disasters (CRED), collaborating center with WHO and United Nations, defines disaster as “A situation or event, which overwhelms local capacity, necessitating a request to national or international level for external assistance; an unforeseen and often sudden event

that causes great damage, destruction and human suffering”. (CRED 2007) The official definition of disasters in the United States is presented in the Stafford Act. The Robert T. Stafford Disaster Relief and Emergency Assistance Act is the primary legislation in the United States authorizing the federal government to provide disaster assistance to states, local governments, families, and individuals (Haghani,2009).

The Stafford Act defines a disaster as “Any natural catastrophe (including hurricane, tornado, storm, high water, wind driven water, tidal wave, tsunami, earthquake, volcanic eruption, landslide, mudslide, snowstorm or drought), or, regardless of cause, any fire, flood or explosion, in any part of the United States, which in the determination of the President causes damage of sufficient severity and magnitude to warrant major disaster assistance under this Act to supplement the efforts and available resources of States, local governments, and disaster relief organizations, in alleviating the damage, loss, hardship, or suffering caused thereby.” As these definitions indicate, a disaster is a “catastrophe” of such magnitude and severity that the capacities of states and local governments are overwhelmed.

So the threshold for determining what constitutes a disaster depends upon the availability of resources and capabilities of responding communities. Consequently, a disaster can be prevented by increasing the capacity of responding organizations.

From a global perspective, the number of natural disasters is increasing every year. For example in 2005, there have been 489 country-level disasters affecting 127 countries around the globe resulting in 104,698 people killed and 160 million affected. For the same year of 2005, the economic damage estimate varies from 159 billion to 210 billion in US dollars. Because of the population growth and new

developments in risk prone regions, the exposure of the human kind to the natural disasters is increasing even more

A least-square linear regression trend-line is drawn to better illustrate the overall pattern. In 1990s, the average number of disasters increases to around 300 per year. And in the 2000-2007 period, these numbers are around 460 disasters per year which indicates a dramatic increase. An increase of this magnitude can be explained partially by the global warming theory, and partially by the attention of the media which has increased the numbers of reported disasters all over the world.

As the number of disasters increases every year, more people are affected by these disasters. The number of victims includes the people killed, injured, lost their homes or evacuated as a direct result of the disaster.

An exceptionally high number in 2002 is due to a drought solely affecting 360 million in India and China and a major wind storm and flood affecting 160 million people in China (Haghani,2009)..

Person Affected (Million) Total Number of people affected 5 average cost per year is \$45 billion from 1980 to 1999. However, for 2000 to 2007 period, the average cost is more than \$80 billion per year. The linear trend-line shows this increase in the economic damage of the natural disasters over time. Two major disasters affecting the trend are the Kobe earthquake in 1995 and hurricane Katrina in 2005. Emergency Management Emergency management (or disaster management) is the discipline of avoiding risks and dealing with risks (Haddow et al. 2007).

## **Method**

The method employed in the present study is theoretical where library method has been used to collect information. Here the crisis and its management have been

initially studied in a supply chain and the main focus has been on the management approach. On the other hand, principal issues of natural disasters management have been discussed.

## **Findings**

Before investigating the crisis management approach in the case of natural disasters, first crisis and crisis logistics have been studied and the main focus has been on its characteristics.

Besides, the principles of logistic management of natural disasters have been studied and, due to the nature of disasters and the approach to managing them in a timely manner, the main cycle of this type of management and its applicable methodology have been scrutinized as well.

## **Definition of Crisis**

- a) The crisis is a sudden or accident together with wide financial losses or casualties and inducing trouble and suffering to a group or a human society whose way of overcoming would be urgent, immediate and extraordinary actions.
- b) The crisis is the force or a set of opposing and unpredictable forces taking place and destructively affecting the foundation and focus of a targeted move and, in the case of not passing through it, would cause unrecoverable damages (Yi & Özdamar, 2007).

## **Crisis Management**

- a) The systematic, genuine and comprehensive process of detection, prioritization, prediction and prevention from a crisis, intervention in the

crisis and purification after the crisis for the purpose of overcoming it or limiting the consequences caused by it.

- b) The process of planning, organizing, guiding, leading and controlling the required activities for preventing any intervention in the crisis in order to prevent the crisis from happening, overcoming it and purifying after it is being taken place (Yi & Özdamar, 2007).

Crisis management is categorized into four phases of prevention, preparation, respond and reconstruction (Bozorgi-Amiri, Jabalameli, & Al-E-Hashem, 2013).

- 1- Prevention: Set of actions executed before the crisis with the purpose of preventing the sufferings or reducing the damaging effects of it.
- 2- Preparation: Set of actions (including gathering information, teaching, researching, planning, providing managerial structures and supplying resources) conducted in order to increase the capability of society, government and people in acting in different steps of crisis management.
- 3- Respond: Includes offering urgent services carried out after the crisis has taken place with the purpose of preserving different sources of the organization to prevent widening the damages.
- 4- Reconstruction: Includes activities in order to return the conditions of a suffered organization to normal conditions considering the features of a successful organization as well as all safety regulations.

### **Definition of the Crisis Logistic**

It has been predicted that until 2125, above 5 billion people will live in urban areas around the world from which 81% will reside in less developed cities and this could induce challenges for urban planners and managers (Chang, Tseng, & Chen, 2007). Undoubtedly, the major influence of accelerated growth of

urbanization and uncontrolled growth of urban spaces would be impairing of the service distribution system and malfunctioning of the service system. Therefore, the optimal pattern of living in urban communities would require suitable planning in the cities. One of the important goals of urban designers is creating an urban space where all citizens could easily have access to city services, because accessibility represents the quality of an urban space (Chang, Tseng, & Chen, 2007). The crisis logistic includes all process of providing, supplying, transporting, storing and distributing articles, equipment, services and all necessities of sufferers and relief groups which should be achieved in minimum time and in suitable places and in essential amount.

### **Characteristics of the Crisis Logistic System**

In recent decades, the logistic system for organizations has been inevitable and has found a role in the organization's costs basket; so that activities of the logistic system could significantly influence on effectiveness and efficiency of the organization.

Expectations and demands of sufferers and relief and rescue groups as consumers and final user of articles, equipment, and support services could be included in the various subject. Providing equipment and essential quality and quantity support in required time and place are among the most important expectations from the logistic system.

Preparing and planning appropriately, the logistic system provides a suitable bed for association and application of maximum power and potential of providers, the way that it could not only attract their confidence, but also provides the sufferers and relief groups with equipment and articles with appropriate speed and quality and in demanded time and place.

This goal would not be realized unless by the formation of a logistic system with

features compatible with crisis conditions and integrated management using modern and efficient information technologies. The effectiveness of the logistic system could be determined via its preparation, speed, and reactivity.

### **Similarities and Differences between Commercial and Relief Supply Chains**

Conceptually, there are some similarities between the commercial and humanitarian relief supply chain; the way that, similar to the logistic concept in the commercial supply chain, the crisis logistic includes activities, such as planning, prediction, supplying, transportation, storage, delivery and also supplementary actions like offering help request and displacement.

The humanitarian relief chain connects all beneficiaries in the relief process. These beneficiaries include donors, relief organizations, army, governments, and sufferers.

Similarities between commercial and relief supply chains in crisis conditions provide possibility of using some tools and methods of the commercial supply chain in the relief ones; however, there are fundamental differences between them causing, even more, complexities and unique challenges in managing relief chains. One of the main differences between commercial and humanitarian relief supply chains is in their goals.

In the commercial supply chain, making the profit is considered as one of the main targets; whereas, in humanitarian relief chains, this goal replaces with on time and suitable relief actions (on time delivery of relief articles in the suitable place) to sufferers.

According to conditions and different aspects of natural disasters, most important features of relief chain that distinct it with commercial supply chains and make the solution of relief logistic problem much more complicated, are as following (Beamon, 2004):

- Lack of information most of which are due to uncertainties and malfunction of connection lines.
- Sudden nature of incidents and time limits in responding the needs
- Limitations in resources with respect to the accident dimensions, such as limitations of articles, human resources, technologies, fuel, transportation fleet and budget available that could cancel rescue and help all sufferers.
- The complexity of coordination due to the presence of different relief groups, people, and government.
- Existence of conflicting target functions
- Unpredictability and uncertainty of demand from time and incident place point of view as well as its type and wideness
- Uncertainties and various dynamic factors in environmental conditions after the accident

Above points have turned the logistic of relief chain into a very challenging topic; such that increasing efficiency and improving the performance of relief actions would require special attention and precise logistic plans and management and complete coordination between related relief staff would seem necessary more than ever before.

It is obvious that paying attention to time in responding to the generated demand and delivering help and services required to suffered points in minimum time is of great importance in relief logistic.

### **Crisis Management Cycle**

The crisis management cycle has four steps including the following (Van Hentenryck, Bent, & Coffrin, 2010):

## **The Step of Expectation and Prediction**

In this Step, conducting the following items is necessary:

- Exact identification of probable mass disasters and develop a geographical map of areas at risk according to type of disaster, severity, and probability of occurrence.
- Developing preventive guidelines about structures (private and public), urban facilities, infrastructures and national treasures.
- Supervising the execution of guidelines
- Identification of technical predictive ways, tools and required instruments for predicting the mass disasters
- Public training in order to enhance the public awareness for the probable mass disasters and suitable individual behaviors in case of incident
- Training the special national and local staff related to type of probable disaster according to local facilities and needs
- Providing necessary equipment for help and rescue and founding permanent relief and rescue basements within national borders
- Developing permanent plans of precautionary and predictive action in national level
- Developing mandatory evacuation plans when necessary and predicting location, facilities and tools and necessary instruments after evacuation of population
- Regular study on possibility of evacuation of endangered areas and changing the use of the land with respect to type of the probable mass disaster
- Regular study of crisis management and deciding in crisis situations and practicing the crisis management guidelines

## **The Step of Warning against Crisis**

In this step, all the following should be conducted:

- Determining ways of warning in case of danger of any mass disaster
- Providing warning tools
- Public training of the signals of mass disaster
- Guidelines for rescue and safety from mass disasters in case of incidence

## **The Step of Rescue**

This step includes the following:

- Identification of the location, severity, and domain of the disaster
- Declaration of public mobilization according to severity and domain of the mass disaster
- Dispatch of special relief staff and necessary tools and working instruments
- Immediate protection of damaged areas from hygienic point of view and social and legal controls of quick transferring of sufferers to prepared centers
- Search and rescue operations
- Evacuation of bodies and burying them and doing necessary hygienic actions
- Evacuation of remainders to points pre-designed in step of expectation and prediction
- Formation of temporary and permanent camps
- Providing the camp residents with daily needs and essential facilities
- Evacuating properties and dividing them

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