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An Overview of Humanitarian Logistics in Brazil

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Abstract

This article presents a conceptual overview of humanitarian logistics and its theoretical evolution. It covers the phases of humanitarian operations in disaster responses, considering their planning and stakeholders. The paper presents an analysis of the humanitarian operation in the immediate response phase of the floods occurred in the mountain region of Rio de Janeiro in January 2011, focusing on the activities of the Brazilian Army. Finally, it summarizes the main decisions to be taken in this type of operation and proposes a structure of the main research areas regarding the planning of activities to be developed post-event.

Keywords: natural disasters; humanitarian logistics; immediate response; Brazil.

1 Introduction

Factors such as global warming, environmental degradation and increasing urbanization expose a greater number of people to the threat of natural disasters. In the last three decades, the rate of disasters has risen from 50 to 400 per year and it is still expected to increase five times more on the next 50 years (Kovacs and Spens, 2009). In 2008, 200 million people were victims of disasters, which caused 240,000 deaths and losses of 230 billion dollars (Blecken, 2010). This increasing incidence of natural disasters impacts not only the population, but also the political and economic systems of the affected region (Rodriguez et al., 2011).

Immediately after the occurrence of disasters, humanitarian operations are initiated with the intent to provide rapid assistance to victims in different ways, such as salvaging those who are wounded, collecting and disposing corpses, resource allocation, provision of food aid, shelter and medical care, and restoring access to remote locations. About 90% of the efforts of a disaster relief operation are related to logistics activities (Trunick, 2005). Besides, in humanitarian actions, delays in delivery or relief can cost lives. Therefore, efficiency in logistics is a key success factor, because it ensures the smooth flow of goods and services in a complex supply chain.

In this context, logistics processes for emergency relief operations are known as humanitarian logistics. Humanitarian logistics deals with a series of natural disasters such as earthquakes, tsunamis, hurricanes, tornadoes, epidemics, droughts, floods, and also with anthropogenic disasters such as terrorist attacks, chemical attacks, refugee crises and nuclear accidents (Kovacs and Spens, 2007, 2009).

This paper presents a conceptual overview of humanitarian logistics and also analyzes the field in Brazil. Humanitarian logistics is still incipient in the country, but we believe that deeper knowledge of this field can help improving the effectiveness of emergency relief operations in Brazil, more specifically, in cases of floods and landslides. Therefore, this paper brings an analysis of the immediate response operation after the floods in the mountain region of Rio de Janeiro in January 2011, using five assessment factors proposed by Martinez *et al.* (2010): (i) access and logistics, (ii) health, (iii) water, sanitation and hygiene, (iv) food and (v) shelters and non-food items.

2 Humanitarian Logistics

Humanitarian logistics deals with planning, implementing and controlling effectively and efficiently the flow of goods, from point of origin to point of consumption, in order to alleviate the suffering of vulnerable people (Thomas and Kopczak, 2007). Therefore, humanitarian logistics is responsible for the preparation, planning, procurement, transportation, storage, tracking and customs clearance (Kovacs and Spens, 2007). This definition of humanitarian logistics has many similarities to the concept of supply chain management, but the term "humanitarian logistics" is the most used (Tatham and Pettit, 2010).

By 2006, there was limited research on humanitarian logistics, with few articles on the subject (Beamon and Kotleba, 2006). But since then, humanitarian logistics started being debated on different platforms, being the theme of special sessions at conferences such as the annual conference of the Production and Operations Management Society (POMS), of the Institute for Operations Research and Management Sciences (INFORMS) and Logistics Research Network (LRN). Special editions on the subject were published in journals such as the International Journal of Physical Distribution & Logistics Management, Transportation Research Part E, POMS and Journal of Production Economics. In 2011, the first journal exclusive on humanitarian logistics (Journal of Humanitarian Logistics and Supply Chain Management) was published. Besides, study groups on the subject were created, such as the Fritz Institute, Humanitarian Logistics and Supply Chain Research Institute at the Hanken School of Economics, the Georgia Tech Center for Health and Humanitarian Logistics, as well as in MIT and in INSEAD. Currently, there are master and doctorate courses on the subject offered at various universities (Kovacs and Spens, 2011). Consequently, it is observed that the discipline has evolved as a theoretical body. However, according to Wassenhove (2006), logistics as a theoretical body is 15 years ahead of humanitarian logistics.

According to Nogueira *et al*. (2008), the conditions faced by companies are different from those faced in a disaster, so there are specific characteristics of humanitarian logistics that differ from the traditional approach of business logistics, such as issues of human life, information systems that are unreliable, incomplete or nonexistent, unpredictability of demand and the "last mile" to transport the aid to victims. Table 1 presents the main differences between business and humanitarian logistics. However, Tatham and Pettit (2010) point out similarities between humanitarian logistics and military logistics such as: a) both present uncertain demand patterns, b) the difficulties faced by the degradation of the physical infrastructure of the site and the absence of certain governmental functions, c) rescue of injured and traumatized individuals and d) both are under constant observation of the media.

Table 1: Main differences between Humanitarian Logistics and Business Logistics

Subject	Business Logistics	Humanitarian Logistics
Objective	Profit maximization	Help and save lives.
Stakeholders	Clients, suppliers and shareholders	Donors, governments, military, NGOs, UN and Beneficiaries
Clients	Final consumers	Beneficiaries
Suppliers	Two to three suppliers previously known	Multiple donors and suppliers without prior Agreement
Duration	Usually lasts for years	Lasts for weeks or months
Demand patterns	Relatively stable and can be predicted using forecasting techniques	Irregular, very uncertain and volatile. Estimated in the early hours of the disaster
Materials flow	Products marketed	Features such as shelter, food, hygiene and cleaning kits and vehicles
Financial flow	Bilateral and known	Unilateral (from donator to beneficiaries) and Uncertain
KPIs	Based on performance metrics	time to respond to disaster, % of unmet demand, meeting the expectations of donors
Main equipment	Trucks, forklifts and common vehicles	Heavy equipment, helicopters, air transportation
Human resources	Skilled labor	high turnover, volunteer work, stressful environment

Source: Adapted from Ertem et al. (2010)

3 Humanitarian Operations in Response to a Disaster

There are different classifications for the different phases of a humanitarian operation. Kovacs and Spens (2009) analyze these different classifications, concluding that: (i) Ludema (2000) distinguishes operations in emergency aid, rehabilitation and development, (ii) Safran (2003) in prevention, transition and recovery, (iii) Pettit and Beresford (2005) in preparation, response and recovery; Kovács and Spens (2007) in preparation, immediate response and recovery. Kovacs and Spens (2009) point out similarities among these different classifications. For instance, the rehabilitation phase of Ludema (2000) is equivalent to the phase of transition from Safran (2003), response from Pettit and Beresford (2005) and immediate response from Kovács and Spens (2007).

According to Kovacs and Spens (2007), the preparation phase is associated with strategic planning for disaster prevention and risk management. The immediate response phase relates to crisis management in the short term by managing demand, supply and distribution. The recovery phase is associated with continuous planning in the long term. After the recovery phase, Kovvor-Mistra and Mistra (2007) also propose a learning phase, in order to stimulate continuous learning that could contribute to avoid problems in the preparation and immediate response phases of future operations.

Ertem *et al*. (2010) point out that in the first 24 hours after a disaster, humanitarian professionals travel to the disaster area in order to estimate emergency needs. According to Chakravarty (2011), it is essential to know the intensity of the disaster so demands can be estimated. In the first 36 hours, resources tend to be released for humanitarian organizations and governments. These resources are defined by type and quantity of material required. Donations should be classified and accounted for, while cash donations should be addressed for the acquisition of supplies. Ertem *et al*. (2010) consider that the first 72 hours are critical and supplies must be transported to the disaster site regardless the costs involved. Banomyong and Sopadang (2010) point out that on these first three days, victims' needs are basically restricted to items of food, hygiene, medicine, clothing and shelter, besides machinery and equipment necessary to assist in infrastructure recovery and in the construction of temporary accommodation. In terms of supplies, humanitarian organizations receive unsolicited donations, which are often unnecessary (Chomolier et al., 2003) and, therefore, tend to be incinerated. Such supplies make operating conditions even more difficult, congesting the system (airports and deposits) and consuming resources for logistics and transportation (Balcik et al., 2010). It may take up to four months for food supplies, in affected areas, to be re-established by a continuous and more stable flow, without the need for emergency measures such as use of air transport (Banomyong and Sopadang, 2010).

Disasters tend to be random events. However, planning and prevention can be done in advance based on previous disasters data (Gatignon et al., 2010). After all, the occurrence of certain types of disasters is associated with specific geographical conditions (Kovacs and Spens, 2009), so it is important to determine which areas are vulnerable to potential disasters and then developing contingency plans and training the population (Rodriguez et al. 2011). The case of Bangladesh can be considered a successful example in disaster prevention (Tatham and Pettit, 2010). The country has one of the worst GDP per capita in the world and its location makes it vulnerable to a number of different types of disasters. However, Bangladesh has developed a disaster mitigation program that has contributed to the reduction of mortality rate in cyclonic events. Cyclone Bhola, for example, resulted in the deaths of 500,000 victims in 1970, while cyclone Nargis, with similar characteristics to Bhola, resulted in 4,200 fatalities in 2007 (Tatham and Pettit, 2010), which is less than 1% of the victims of cyclone Bhola.

Another relevant point to be highlighted in humanitarian operations is the number and diversity of actors involved, which can be donors, volunteers, public agencies, government, military, non-governmental organizations (NGOs), private companies and logistics operators. The involvement of international NGOs is critical in this type of operation because of its political neutrality and its relationship with the target population, allowing them access to politically unstable countries, which otherwise would not allow outside interference (Rodriguez et al., 2011). However, several NGOs can be working in a humanitarian operation, each with its own specific mission, different interests and abilities (Balcik et al., 2010). For

instance, 40 countries and 700 NGOs acted on the humanitarian operation after the 2004 tsunami in Indonesia (Balcik *et al*., 2010) and 100 NGOs worked on the operation response to the 2005 earthquake in Pakistan (Tatham and Kovacs, 2007). This large number of stakeholders involved, associated with the multiplicity of objectives of international humanitarian organizations, greatly increases the complexity of implementation and coordination of disaster relief operations (Tatham and Houghton, 2011).

In order to ensure greater predictability, accountability and partnership, the United Nations introduced, at the end of 2006, eleven clusters as a classification of humanitarian activities. Stakeholders can be classified according to these clusters, facilitating the definition of roles and responsibilities. Thus, this classification can be used as a strategic tool to improve the effectiveness of humanitarian response. Martinez *et al.* (2010) selected five of these clusters related to the response phase of a humanitarian operation, which were adopted as factors to assess the immediate response operation in Haiti after the earthquake in 2010: (i) access and logistics, (ii) health, (iii) water, sanitation and hygiene, (iv) food and (v) shelters and non-food supplies. These factors were also used to evaluate the response phase of humanitarian operation after floods in the mountain region of Rio de Janeiro in 2011.

4 Background of Humanitarian Logistics in Brazil

Disasters can be natural or anthropogenic. However, terrorist attacks, chemical attacks and refugee crises are not one of the main concerns in Brazil (Nogueira *et al*., 2008). In the context of anthropogenic disasters, humanitarian logistics is more applicable in the country in eventual accidents in the nuclear power plants Angra I and II. Regarding natural disasters, the country usually does not suffer large magnitude earthquakes, tsunamis, typhoons or tornadoes. In 2004, the first recorded hurricane occurred on the Brazilian shore, Catarina, which damaged 53,000 buildings and left 2,200 homeless (Nogueira *et al*., 2008). However, the country often suffers from droughts, floods and landslides. 58% of all natural disasters occurred in Brazil are floods and 11% are landslides (Thenório, 2011). Moreover, INPE Climate report shows that extreme precipitation events may become even more frequent, causing floods and more severe landslides in the country (Nogueira *et al*., 2009).

However, the concept of humanitarian logistics is still incipient in Brazil, with very few academic studies. The government neither invests solely on prevention. In 2010, the Federal Government has invested 14 times more to remedy damage caused by rain than in prevention (Campanato, 2011). Nevertheless, it can be observed the development of studies and prevention planning and mitigation of disasters in the country, such as the National Alert System and Disaster Prevention Program. It is a project of the Ministry of Science and Technology that aims to reduce the number of deaths caused by floods and landslides. The first stage of this project is mapping 800 high-risk areas throughout the country. These maps are input data to a software that will cross weather information (risk of rain, floods, winds etc.) with the most vulnerable regions to disasters (Thenório, 2011). As a result, it will be possible to warn communities about the impending disaster. However, the population should be trained so it will be known how to act after receiving the alert. In Brazil, there is a lack of pre-event plans or preparedness tactics.

5 Analysis of the humanitarian operation after the floods in the mountain region of Rio de Janeiro

For this analysis, the research method used was qualitative, applying bibliographical research and case study techniques. Interviews were conducted with personnel who participated in the humanitarian operation response phase. The interviews were analyzed using content analysis technique. The categories were defined *a priori* according to the factors proposed by Martinez *et al.* (2010), based on the eleven UN clusters: access and logistics, health, water, sanitation and hygiene, food, and shelter and non-food supplies.

5.1 Climate disaster in the Rio de Janeiro mountain region

The tragedy has directly affected 20 counties and 90,000 inhabitants. There were 30,000 homeless and displaced victims, and 916 deaths from floods and landslides that occurred between 11 and 12 January 2011. This disaster was the largest in the country and the world's tenth worst slide in the last decade (O Exército, 2011). The city with more victims of the tragedy was Nova Friburgo, followed by Teresópolis, Petropólis, Sumidouro, Sao Jose do Vale do Rio Preto and Bom Jardim. In Teresópolis, there were a total of 5,000 homeless and 6,000 displaced victims.

The main causes of this natural disaster were: local geology, irregular soil occupation (on slopes and floodplain areas) and high intensity of rainfall concentrated in periods of 15 minutes. . Nonetheless, such disasters historically occur in Rio de Janeiro State every year between November and April caused by these same reasons. Therefore, it becomes apparent that low investment in disaster prevention and mitigation has been done in Rio de Janeiro. In 2010, the amount invested ($ 80 million) for reconstruction of locations hit by the rain was ten times the amount invested ($ 8 million) for disaster prevention (Campanato, 2011).

Disaster prevention and mitigation planning, associated with the immediate response and recovery planning, would be effective to reduce the impact of floods and landslides in Rio de Janeiro, such as the emergency plan developed by Costa Rica. This country has a similar topography to Rio de Janeiro and in 2010, also went through high volumes of rain, but without a large number of casualties. When signs of a possible disaster are detected, the National Meteorological Institute of Costa Rica issues a warning to the National Emergency Commission, which forwards the information to Local Emergency Committees, responsible for activating mechanisms of response to the Operations' Coordination Centers. These centers coordinate search and rescue patrols, evacuation, sheltering and damage assessment, besides centralizing the distribution of humanitarian assistance and donations to the community. The development of similar plans in Rio de Janeiro is essential, because, even when the possibility of a calamity is pre-diagnosed, there is no coordination on the part of state institutions regarding prevention and response activities. Currently, the National Civil Defense is limited to helping the victims after the tragedy strikes.

5.2 Analysis of the humanitarian operation

The stakeholders involved in the immediate response phase of the humanitarian operation for the flood disaster in the fluminense mountain region were: state government, local cities governments, Civil Defense of Rio de Janeiro State, National Security Force, Rio de Janeiro State Fire Department, Brazilian Navy, Air Force and Army, and support NGOs. In the first two days, these different stakeholders acted disjointed and without coordination through individual and anarchic actions. At times, there even was overlapping of efforts to act in the same problem, causing poor efficiency. However, the guideline of the National Security Force was the collaboration among the different actors, under the coordination of local Crisis Management Centers, established by local governments. Therefore, these stakeholders were managed by the Crisis Management Center.

The military participation in humanitarian operation took place by decision of the President, assisted by the Defense Minister and the Institutional Security Minister. The Brazilian Army's mission in the response phase of the event was to support the Civil Defense agencies of the affected towns, performing logistical tasks, such as: distribution of donations, transportation of refugees and evacuation of wounded, water treatment and distribution in areas of difficult access, removal of debris (clearance pathways) and religion assistance. As this research focuses on analyzing logistics operations in the immediate response phase, the study was based on the action of the Brazilian Army.

5.2.1 Access and logistics

Access to the highlands of Rio de Janeiro State takes place from four roads: BR 040, BR 116, BR 101 and RJ-116. However, some portions of these roads were blocked due to the landslides, being released a few days after the flood. However, several roads inside the city of Terespólis were blocked due to falling

barriers that isolated communities. One month after the disaster, access to all areas where there were victims had been restored.

Brazilian Army played a major role in clearing debris and pathways, using specialized vehicles and equipments. This action was essential to enable the distribution of donations and assistance. After all, in the first seventy-two hours after the disaster, the Fire Department was facing great difficulties to carry out search and rescue patrols. Military engineers also launched bridges that enabled. Two bridges were launched, one on the Grande River in the town of Bom Jardim, and another on the Paquequer River, restoring access to isolated areas.

The Brazilian Army participated on search and rescue patrols, on the distribution of emergency supplies, transportation of homeless/displaced and on the evacuation of wounded victims. A large volume of donations was required to attend the increasing demands of the victims. The transport of donations from other regions of Brazil to Rio de Janeiro was performed by the Air Force, which provided aircraft, trucks and trailers and also performed traffic control. The use of helicopters was essential to the distribution of supplies to victims in isolated areas and it was also used for evacuation and transportation of victims. Just in Teresópolis, the Army had the support of 42 vehicles and four helicopters during the immediate response of the humanitarian operation.

One of the difficulties faced by the military was the dilemma in prioritizing needs for various requests of evacuation and supply distribution due to the restricted number of vehicles and human resources available. Therefore, a critical decision to be taken in the operation refers to planning efficient use of available resources. Another important role played by Brazilian Army was mapping of the mountainous region immediately after the disaster, in order to show the best access to areas that were still isolated, thus facilitating the work of rescuing victims. This measure also facilitates the identification of inappropriate areas for new constructions.

5.2.2 Health

The military provided health support making available medical, dental, X-ray, pathology, evacuation and psychological professionals that provided a range of health services to the affected populace on Military Combat Support Hospitals. The Military Combat Support Hospitals have been a solution in assisting victims of disasters in Brazil, especially in cases of floods and landslides, such as the analyzed event. These hospitals were essential to reduce the waiting time for the victims in Teresópolis, given the partial destruction of local resources. They offer medical care services from different specialties, such as internal medicine, orthopaedics, paediatrics, gynaecology and dentistry. They also have operating rooms, X-rays, labs and beds for short periods of recovery. When it was necessary to transfer patients, aero medical evacuation was used. In the first seventy-two hours after the disaster, 75% of all medical services provided by Military Combat Support Hospitals were clinical cases, 20% were orthopaedic services and 5% were psychiatric cases. After physical trauma, fractures and injuries, most of the services provided involved victims with psychosomatic problems caused by emotional sequeael.

Essential medical services also involved the control of leptospirosis and hepatitis B, diseases to which population is vulnerable in cases of floods. Another important point to maintain good health condition is removal and burial of corpses. The Brazilian Army supported these activities, and also provided religious assistance. From this experience, it was identified difficulty in estimating the amount of critical medical supplies required by victims, since there are no surveys on types of accidents and injuries most common in these types of disasters. Also, there were difficulties due to shortages in the supply of drugs and blood donation. Therefore, the main decision is the allocation of resources, such as doctors and medicine, to maximize attendance.

5.2.3 Water, sanitation and hygiene

According to the International Red Cross, the daily demand for drinking water per person in cases of disasters ranges from four to five litres/person daily, including in this estimate consumption by hospitals and health clinics (Martinez *et al.*, 2010). The population of the cities hit by the disaster is approximately

700,000 inhabitants and 30,000 victims were homeless. Thus, it required a minimum of 150,000 litres of water daily to meet the needs of homeless/displaced by the disaster.

Water is a critical issue for survival, so it was treated as a priority in the first days after the disaster. Companies and people of Rio de Janeiro have donated large amounts of drinking water in response to requests from media (television and radio). However, restoring the water distribution system (as well as power and sewage) was under the responsibility of local utilities, which carried out the required work.

5.2.4 Food

In cases of major disasters, two considerations must be analyzed relative to food: (i) assist the population impacted, and (ii) provide food to people, volunteers and professionals. Specifically, in the Army, 868 meals were served per day to feed the troops employed to assist in Teresópolis. In this respect, it was necessary to control the distribution of food in order to meet the entire contingent. Food distribution in cases of humanitarian operations is a network flow problem with multiple modes and multiple commodities, whose objective is to maximize the service demand as the response time is minimized (Martinez *et al.*, 2010). This problem becomes even more complex because some roads have their traffic blocked due to landslides or floods.

A constant replenishment of food items was required, but there is a lack of studies relative to demand forecast of needed supplies. There was an immediate response from businesses and the population of Rio de Janeiro to provide food supplies. Food items and other donations were stored in private distribution centers and warehouses or even on public schools and stadiums. The main decisions to be made regarding the distribution of food refer to: how to transport the donations to the disaster area, where to store it and food distribution.

5.2.5 Shelters and non-food supplies

The homeless population was initially sheltered in schools and warehouses that could receive them. Some victims were also sheltered in tents similar to those used in the Haiti earthquake and the tsunami in Indonesia (Lauriano, 2011). These tents, with capacity for ten people, have survival gear, stoves, cutlery, pans, dishes, blankets, purifying and storing water. Sheltering plan was organized by the municipal authorities, which adopted the strategy of minimizing the number of sheltering sites, concentrating victims on fewer locations.

Regarding non-food supplies, there was excess of donations of coats, pants and shirts. Meanwhile, there was a shortage of items such towels, underwear, bed linen and gas cylinders (O Exército, 2011). It was very difficult to estimate needs according to the evolution of events, so a constant replenishment of items was necessary. But as soon as the media announced the shortage of an item, such supplies were soon received through donations. The top decisions to be made, regarding this aspect of the humanitarian operation, are: a) forecasting the demand for shelter and non-food supplies, b) how to meet victims' demand, and c) how and where to shelter the homeless.

Brazilian Army acted on the preparation of packages with relief supplies as well as on supply distribution. Supply distribution was managed and controlled by the Crisis Management Center, which received requests from the victims and then generated delivery orders for the Army.

5.2.6 Summary of military involvement

In summary, Brazilian military involvement in the disaster relief operation at Rio de Janeiro State took place in the immediate response phase, more precisely, on the first fifteen days after the disaster. Responsibilities were then taken over by humanitarian NGOs or government agencies, during the reconstruction phase. Initially, Brazilian Army acted on the evacuation of wounded victims and transportation of homeless/displaced from risky areas, as well as on water and food distribution and on restoring access to the affected areas. Nonetheless, military involvement increased according to the demand and needs of the affected population. After an initial moment, Brazilian Army started acting on health support and on supply distribution. Finally, it supported activities related to sheltering and vaccination. Figure 1 summarizes in three stages the military activities in disaster. It is important to stress

that all the activities have been developed to support procedures that were being performed by other governmental and nongovernmental institutions, mainly from the second stage on.

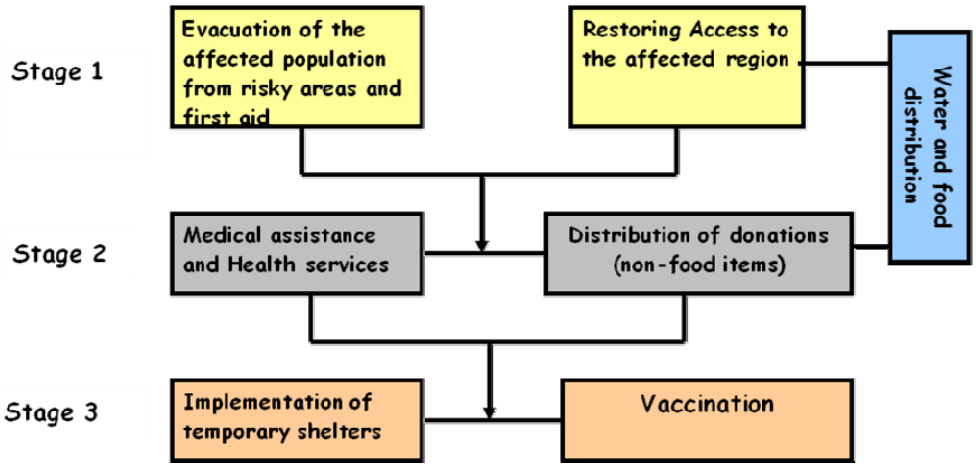

Figure 1: Framework of Military participation in humanitarian operations. Source: Authors, 2012.

6 Areas of Practice and Research

From the literature review and the assessment of the natural disaster occurred in Rio de Janeiro in 2011, five important research areas were identified for planning humanitarian logistics activities to be conducted on the immediate response and recovery stage of disaster relief operations, as shown next.

- Information- This area includes a geo-referenced mapping of areas vulnerable to accidents, including socioeconomic data of the population, potential housing sites, warehouses and access roads. This step is one of the most important, because this information provides a first idea about demand. Moreover, it is important to have information about possible aid institutions, or where funding may come more immediately.
- Team Allocation- This area includes the definition of the different types of equipment required to rescue people in danger, for clearing debris, to restore access to roads and installation of shelters, as well as the definition of the number of doctors, nurses, social workers, logistics professionals and volunteers needed. In addition, civil engineers and technical staff are required for recovery of basic services like water, electricity and sewage.
- Sizing of supplies- It comprises typology and quantification of essential items to be distributed, such as food, clothes and furniture, mattresses, stoves, bedding, blankets, as well as the amount of shelters required. It is important to develop models that enable the quantification of these needs.
- Logistics and Distribution Access- It includes an initial definition of how to reach the disaster area most immediately in order to rescue people in danger and to get all the equipment, donations and personal to help the population. Subsequently, it involves the distribution of these supplies directly or from local warehouses. For a better performance in this area, it is important to check how business logistics methods can be applied in these situations.
- Reconstruction and Mitigation – It includes an investigation of how much was destroyed and needs to be rebuilt, so that the region goes back to its pre-event routine. This action should be initiated as soon as the situation stabilizes in the affected area and should be implemented alongside mitigation measures that reduce the chances of further accidents. The implementation of these activities requires calculation tools and techniques to estimate financial resources and staff required.

The proposed research areas, previously presented, include the possible situations faced in emergency relief operations. Besides, these research areas represent a sequence of activities to be developed in disaster situation: (1) Information, (2) Equipment Sizing and Teams, (3) Sizing of supplies, (4) Logistics and

Distribution Access and (5) Reconstruction and Mitigation. Some of these activities should be developed almost simultaneous, as the activities (2), (3) and (4). Therefore, it is crucial to develop studies to detail these processes so they can be implemented as objectively as possible in cases of disasters. Table 2 resumes general tools to be developed for each research area, considering the characteristic of an emergency situation.

Table 2: General tools for each research area

Research areas	Tools
Information	Database and GIS software
Equipment Sizing and Teams	Demand models for Services
Sizing of supplies	Supply-Demand models and Inventory methods
Logistics and Distribution Access	Localization and routing methods
Reconstruction and Mitigation	Environment and cost assessment methods

7 Conclusion

The article presents a conceptual approach on humanitarian logistics, which is required considering that this field is still incipient in Brazil. It also discusses prevention planning and disaster mitigation. However, it is important to stress that even with the adoption of mitigation measures, disasters still occur. Recent events, such as tornadoes in the United States and the tsunami in Japan in 2011, are examples that even developed countries are vulnerable to the adverse impacts of natural phenomena. Therefore, it is necessary to plan for the immediate response and recovery phases of humanitarian operations. For this reason, it is important to analyze immediate response phases of humanitarian operations, such as studied in this research in the floods occurred in Rio de Janeiro in 2011.

The research proposes a framework for military participation in humanitarian operations and also identifies the main decisions taken in the immediate response after the floods in the fluminense mountain region in 2011. From this assessment, five research areas regarding performance of humanitarian logistics were identified. It is considered essential to develop researches in these areas in order to meet the challenges of humanitarian logistics.

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