



## Improving the Operational Efficiency of Humanitarian Logistics in the Aftermath of a Large-Scale Disaster

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**Abstract** A poor logistics operation in support of relief efforts in the aftermath of a large-scale disaster may cause severe difficulties, which is often called the “second disaster”. Based on the authors’ interview surveys with government agencies, NGOs, logistics companies, and victims regarding the logistics issues during the aftermath of the 2011 Great East Japan Earthquake and Tsunami, this study discusses problems related to the logistics operations for handling donated goods from both domestic and international donors. Several problems occurred due to poor disaster logistics preparedness and a lack of understanding of logistics issues on the part of the actors involved. As a countermeasure, this study suggests an integrated logistics to standardize the relief goods, handling methods, and the logistics system to reduce response time and improve the efficiency of the operation.

**Key words** humanitarian logistics, handling problem, standardization

### 1. INTRODUCTION

In the aftermath of a large-scale disaster, problems related to the distribution of relief goods were occurred repeatedly, for example, 1) storage facilities overwhelmed by unwanted items, 2) uneven distribution, 3) goods not reaching to victims, and many other problems. These problems are the so-called “second disasters”. The consequences of such poor logistics management have been documented previously. For example, at least 20,000 m<sup>2</sup> of land was needed for burying the clothes donated to the victims of the 1992 Hurricane Andrew in Florida (Greve 1999). Hogland (2007) reported problems due to too many donated toothbrushes. Similar problem occurred during the 2004 Sumatra Earthquake (Russell 2005). In the aftermath of the 2011 Great East Japan Earthquake, many media reported insufficient relief goods but, at the same time, only half of the donated goods were useful to the victims. Unfortunately, these problems are repeated over and over again.

Under the situation when only limited locations are usable for the disaster operations due to damage to

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lifeline infrastructures, a fast and efficient logistics system is required to be able to cope with continuous incoming goods, and hence avoid the second disaster. To achieve this logistics system, firstly, we need to prioritize relief goods appropriately, conscious that needs shall change over time and will vary by location. The criteria include the degree of usefulness and urgency. In reality, all relief shelters and depots are unlikely to become fully operational at the same pace. We need to take into account needs that vary by location and time as a response to the average need is unlikely to suffice.

Many research studies have summarized the logistics related problems found during operations in the aftermath of disasters. Kovac and Spend (2007) summarized the characteristics of humanitarian logistics and suggested the points to be considered for the disaster relief logistics at different time phases. Holguin-Veras et al. (2007) discussed the problems found during the response to Hurricane Katrina and provided some suggestions for an improvement of such operations. Among many other problems, they identified the lack of planning for handling and distribution of donations. In order to help tackle these problems, this paper focuses on the practical issues for handling and managing goods distribution, and provides suggestions on an efficient structure for distributing the goods. The problems related to the relief goods distribution are discussed based on our interviews with victims, NGOs, government agencies, and logistics companies involved in the relief efforts during the aftermath of the 2011 Great East Japan Earthquake. Next, this paper suggests an integrated logistics to reduce the response time and increase the operational efficiency in such situations. The operational efficiency can be improved by a well-coordinated response among the actors and agencies involved and by utilizing the knowledge and resources available in the commercial logistics sector where possible. These resources include the unit load system using pallets and handling equipment. In a disaster situation, often the goods cannot be handled fully by existing advanced technologies due to limited resource (e.g., lack of trained staff and/or equipment) or due to limited accessibility to the facilities. This study thus proposes the design of packages including their size and weight so that the goods can be easily handled manually since often the locations of the recipients are not suitable for the use of standard logistics equipment. This paper attempts to develop an overall operation to improve the operational efficiency of the humanitarian logistics. This paper focuses on the Japanese situation and its recommendations are hence most relevant to Japan. Most of the issues discussed are relevant to disaster logistics in other countries though many of the recommendations may need to be adapted to fit local circumstances.

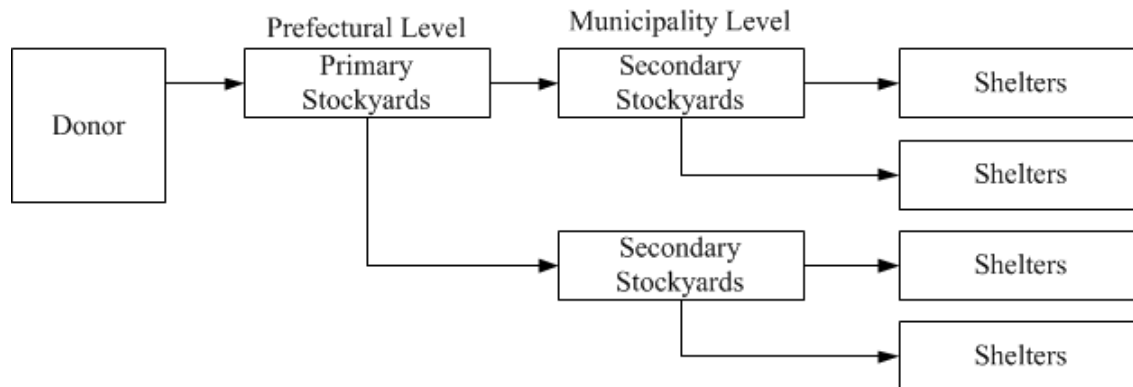
## **2. INTERVIEW SURVEY AND OTHER INFORMATION SOURCES**

The issues discussed in this paper are developed based on primary and various secondary sources. The primary sources are from our interview survey conducted during March and April, 2012 with various key players involved in relief distribution during the aftermath of the 2011 Great East Japan Earthquake in Miyagi Prefecture. The respondents include local government officers, victims and managers at the shelters, NGOs, logistics companies, and private suppliers. The respondents have given their opinions on the problems related to the distribution of relief goods provided by both government and the private sector. The other sources include many reports, studies, news, and especially a report from the Japan Warehousing Association (2012) who contributed substantially to the operation of the temporary warehouses for delivery of critical goods to the victims of the disaster. The report summarized discussions among eight managers from the logistics companies involved.

## **3. METHODOLOGY**

In Japan, relief goods are generally delivered from the primary stockyards to the secondary stockyards and are later sent to shelters where survivors are catered for. The structure is as shown in Figure 1.

However, there were many cases where donors sent goods directly to the secondary stockyards or to the shelters. For example, Ishinomaki city (a secondary stockyard) directly received a greater than required amount of donated goods after media reported the problem of insufficient goods in the city. Similarly, some goods were also donated directly to shelters. As a result, the storages at the stockyards or at the shelters were overwhelmed by the donated goods and this caused difficulties in handling the goods.



**Figure 1.** Flow of the relief goods in Japan

#### **4. THE SECOND DISASTER DURING THE AFTERMATH OF THE 2011 GREAT EAST JAPAN EARTHQUAKE**

Many interviews and reports indicated similar problems occurred during the aftermath of the earthquake; which are, for example, uneven distribution (many shelters received more goods than necessary while many others were in shortage) and a very long delay for handling the goods. Many trucks were on standby at a stockyard from 6 o'clock in the morning and were only loaded at around 6 to 7 o'clock in the evening (Japan Warehousing Association 2012). Based on our interview survey and other reports, the problems identified are discussed in the following sections.

##### **4.1 Problems Concerning the Donated Goods**

After the disaster, a large number of goods were immediately delivered to the shelters. However, many of the goods were found useless for the victims at that time and blocked the working space for handling and storage of more useful items. The problems concerning the donated goods were:

- 1) Totally useless goods, ie. high heels, dirty cloths, and so on.
- 2) Useful Goods at the wrong time, ie. summer cloths in winter
- 3) Expired goods
- 4) Useful goods but too many in quantity

##### **4.2 Problems Concerning the Handling of the Goods**

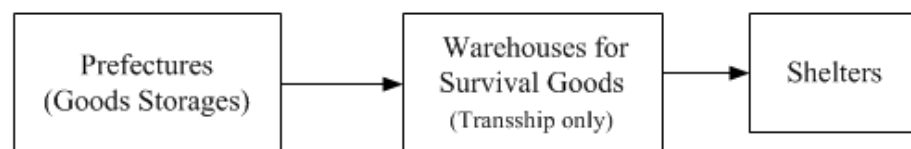
During the handling operation, there was no rule for handling of the goods and, as a consequence, the operation was inefficient and this caused very long delays. The handling problems included:

- 1) Insufficient handling equipment and/or labor.
- 2) Improper packaging of the goods.
- 3) Insufficient information given about the donated goods.
- 4) The goods delivered from abroad were given descriptions in foreign languages and this caused delays in handling due to the language barrier.
- 5) Delay due to an unclear understanding on the scope of responsibility for the delivery between donors and recipients.
- 6) As there was no system to monitor the storage of the goods, staff could not know whether or not the goods were available or sometimes they did not know the storage location, and hence the goods could not be distributed to victims.

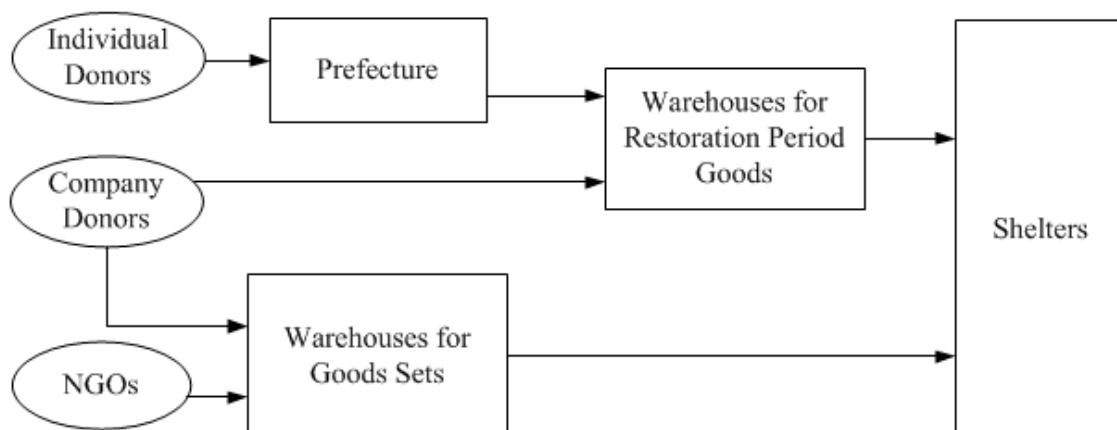
## 5. A PROPOSED LOGISTICS SYSTEM

To achieve an efficient logistics system, we need to consider carefully the characteristics of the needs and the goods at each time phase. The characteristics and the requirements during the survival and the restoration periods are totally different. The goods should be, at first, prioritized by their necessary and emergency levels. During the early period after a disaster, the goods having the highest priority are normally the basic goods required to maintain the needs for survival (which are called survival goods hereafter). Time is the most critical criterion while distributing the relief goods during this period since a faster operation can help save more lives, as well as ease victims' distress. After the situation turns to the restoration period, the needs of victims will increase in variety as time passes. Victims will require a greater diversity of goods and at the same time the lot sizes of the goods becomes smaller while the delivery times becomes less urgent. Understanding these unique characteristics of the goods and their requirements at different time phases can help to improve the logistics operations.

### Logistics during survival period



### Logistics during restoration period



## Figure 2. A proposed Logistics System

Our proposed logistics system for distribution of the relief goods to victims during the survival and the restoration periods are as shown in Figure 2. To be able to adapt to the different goods required at varying levels of urgency, we suggest a separate logistics system for each period: a logistics during the survival period and another during the restoration period. We suggest preparing three different warehouses for the operations: 1) warehouses for the survival goods, 2) warehouses for the restoration goods, and 3) warehouses for other less urgent goods (e.g., school supplies for children, make-up for women) which we designate as “goods sets”. The first two warehouses may be decided right after a disaster but the warehouse for the goods sets is suggested to be prepared in advance. In addition, when dealing with the first two types of warehouse, each shelter should always only receive goods and have contact with a specified warehouse in order to avoid receiving duplicate goods. The details for operating each of the warehouses are provided in the next sections.

Much research, such as those summarized by Hanaoka (2013), have suggested the goods flow following the basic procedure in which the goods are first gathered at the primary stockyards, and later delivered to the secondary stockyards and to the shelters accordingly. However, in practice during the Tohoku disaster, many goods were sent directly to the secondary stockyards or to the shelters without passing through the primary stockyard. This movement caused many problems as some shelters received duplicate goods. This situation happened probably because the staff at the secondary stockyards or at the shelters were too busy to check the stock level as they generally had to deal with many other more important issues. To overcome this problem, we suggest establishing cooperation between the affected and unaffected municipalities soon after a disaster. The goods should be sent, at first, to the primary stockyard outside the affected area before being sent to the secondary stockyards or to the shelters. This procedure can more easily manage and control the storage of goods and can prevent duplicate goods being delivered to the shelters.

### 5.1 Logistics During the Survival Period

During the survival period, the goods supplied to victims are those pre-stored by the government, local governments, and international organizations. In general, the delivery of goods during this period is mainly performed using road transport. The goods supplied by the private sector and by individual donors will begin once the initial crisis period is over.

Here, some examples of the goods distributed to victims during the survival period in the past disasters are provided. During the 2011 Great East Japan Earthquake, the goods received from foreign countries included (Asahi Newspaper, 2011): ready meals (such as, canned foods, biscuits, cookies, instant noodle cups, etc.), water, and blankets. Based on the Aichi prefecture website (2013), the goods that were requested from the prefecture and the goods that the prefecture decided to deliver to the affected regions after the earthquake on March 11th, 2011, were: 1) food and blankets on March 13th, 2) food, blankets and water on March 14th, 3) napkins on March 15th, and 4) food, water, daily goods, and powdered milk on March 17th. All items were those already stored by the prefecture. In the case of Korea, the Korea Disaster Relief Association had provided hygiene sets which contained a towel, a toothbrush, paper tissues, soaps, and so on (Bae 2011).

From the above information, most of the goods provided during this period are rather similar. The goods are mainly blankets, water, preserved foods (that can be kept for a long period), daily goods, powdered milk, and baby feeding bottles.

In the case of food, we need to be careful to sensitive issues such as religious prohibitions and also that the food can be easily opened and consumed (such as an easy-open canned food without a need of can

opener).

During this initial period, the goods from these organizations are rather similar and often come in large lot sizes. Under this circumstance, time is the most crucial issue, and thus the logistics should be able to handle and distribute quickly a large amount of similar goods. As very large-scale disasters worldwide occurred in recent years, there is a need to prepare logistics systems to supply relief goods from foreign countries as well.

The logistics during the survival period is very unique since the response time is the most important. We suggest the following in order to achieve a successful logistics operation during this period:

*1) Prepare a storage space for survival goods separate from other goods*

The goods required during the early period after a disaster have different characteristic from other goods and thus require a different handling method due to 1) large lot sizes, 2) low variety, and 3) a need to operate with imperfect infrastructure. It is thus suggested to separate the storage space of these goods from those required in the later stages of the relief effort. This method can avoid mistakes due to confusion and thus reduces delay. Normally, a long warehouse picking time is required when very different goods share the same space (Japan Warehousing Association 2012).

To prepare this storage warehouse, it is suggested to identify facilities around the affected region where electricity still operates as a working space for distributing the survival goods. These spaces can be temporarily used for receiving and distributing the goods. Due to the above reasons, this facility should only operate with survival goods. In addition, as the road conditions inside the affected region are most probably degraded, the characteristics of the logistics in the affected and unaffected regions are likely to be very different. These facilities can be located so as to connect the logistics operations inside and outside the affected region. Due to the potentially severely degraded infrastructure, the logistics within the affected region may be expected to be primitive and to mainly rely on man power rather than on technologically sophisticated equipment.

In addition, these spaces may be used as a point to separate the delivery responsibility between different actors. As an example, The Epoch Times (2011) reported a conflict between the Chinese and Japanese governments due to an unclear situation about who should be responsible for bringing the goods from the port to the shelters during the aftermath of the 2011 Great East Japan Earthquake. The Oslo Guideline discusses the responsibility of goods donation (2007). In order not to increase the burden on the affected country, donor countries should provide the transportation for the goods donated. Therefore, such facilities can possibly be used as a point to divide the delivery responsibility between the donor and the affected countries.

*2) To prepare a system to control the level of incoming goods*

The problem of receiving goods in too great a quantity has often occurred (Greve 1999; Hogland 2007). A system to control the incoming goods from donors is required in order to control their quantities and hence to prevent unwanted goods disrupting the relief operation. We suggest that donors confirm the quantity of the goods required with the recipient country before sending. Although, in general, during the initial period, goods for which type, location, and quantity are predicted in advance are mostly pushed down through the supply chain; and after the situation improves, goods will be rather pulled through supply chain based on the need (which means that the needs, in terms of type, location, timing, and quantity become clear). During the survival period, goods should be treated with a mixture of both push and pull type approaches. More precisely, the types of goods to be provided should be decided in advance (in the style of push logistics) in order to reduce delays; on the other hand, before delivering the goods to

the affected localities, the donors should confirm with the recipient authority the quantity, time, and location (a characteristic of the pull logistics). Under the constraints of an imperfect infrastructure during the critical initial period, it is very important to bring only the necessary goods to the locality in order to avoid blockages and delays at connection points. The goods provided during this period are rather similar across organizations (central and local governments or foreign organizations). Generally, the providers of the goods are rather limited in number, thus with good procedures, the incoming goods are not difficult to control. The following procedure is suggested:

- Under this circumstance, the goods needed to be distributed quickly. In order to reduce delays, the most pertinent information is perhaps not what kind of goods are needed by the recipients, but instead the numbers of different kinds of survivors. For example, instead of requesting powdered milk it is better to know how many formula feeding mothers are in a given shelter. This method is similar to the push logistics and thus can reduce delays. However, the management should be in the pull manner when dealing with the quantities required in particular shelters and hence their stockyards in order to prevent blockages caused by unused goods.
- During the initial period, it is difficult to correctly confirm the number of victims. Thus the possible number of victims must be predicted from the circumstances, and then the according quantities of basic survival goods readied for distribution.
- Unaffected municipalities should contact and confirm with the affected municipalities about what kind of goods to offer, the quantity, and the location and time the goods will arrive. The capacity of the logistics operation at the affected locality to absorb goods should also be considered before delivery since goods that cannot be delivered to the recipients due to capacity constraints can restrict working space and cause delays. The communications should be in an electronic format for reasons of speed and accuracy. After confirmation from both sides, the goods can then be delivered. This method can control the level of the incoming goods to stockyards and shelters in the affected locality.
- Often, the goods from foreign organizations arrive too late to meet the needs of victims due to long delivery times, possibly including custom delays. Thus, a pull type logistics with adequate coordination on customs issues and the confirmation of the arrival time and the quantity of the goods before delivery is necessary.

This procedure can help to control the level of incoming goods and prevent stockyards being overwhelmed.

Figure 3 shows the control of goods flow from donors up to their delivery to victims. The primary and secondary stockyards are suggested to be used only for the transshipment avoiding where possible the storage of the goods.

### *3) To minimize time required for customs processes*

All goods from foreign countries will need to pass through a customs process. Generally, the time required for this process is rather long. In particular, medicines normally require a considerable amount of time for this process (Japan Institute of Logistics System 2012). Due to this time delay, some goods from foreign countries reached victims too late, and finally were disposed of (Japan Warehousing Association 2012).

We suggest reducing this problem by providing clear statements of the customs provisions for emergency goods of any potential recipient country. Also, this time loss might be reduced by preparing for the temporary relaxation of import regulations for emergency goods in advance.

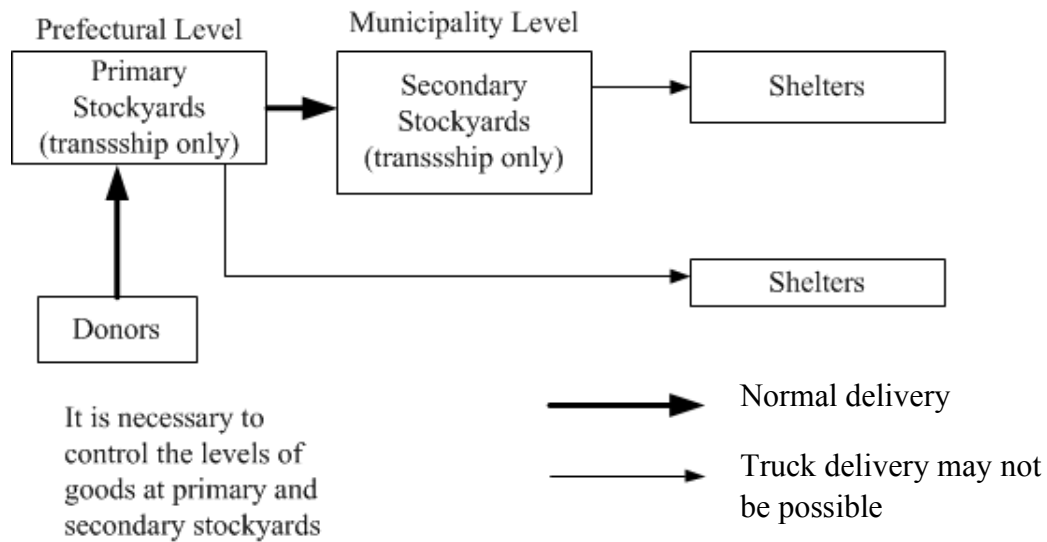


Figure 3. Controlling the goods flow from donors to victims.

4) *To improve the work efficiency at the primary and secondary stockyards*

The primary and secondary stockyards should work as the transshipment points and are very crucial to the overall operation. It is important to increase efficiency at the transshipment points. Our suggestions to improve this efficiency include:

- **Standardize the packaging for each type of good for ease of handling.** The size of package and the quantity in the package should be the same for each goods type. For daily products (eg. shampoo, toothbrush, etc.), it is suggested to prepare in a set for easy distribution to victims. In addition, the quantity in each package should be suitable for manual handling. Inside the affected region, manual handling is often unavoidable. For example, a standard package of blankets contains 10 pieces which weigh approximately 15 kg. Considering the possibility of manual handling, it is suggested to prepare a lighter package of 5 pieces instead.
- **Standardize the codes of goods on the packages.** The code on the package should follow a worldwide standard and should be easily understood. Coding the goods by numbers or by illustrations eases understanding. In a disaster situation, work is mainly performed by volunteers who know very little about logistics. Many instances have been recorded when dealing with foreign goods led to delays due to the need to open the packages to confirm what they contained. This language problem could also cause an unexpected harmful result. In one of our interview surveys, a victim drank a bottle of unknown liquid with the expectation that it was a bottle of water, which fortunately it was.
- **Unit load system.** Survival goods are normally the same limited set of goods that come in large lot sizes. The “unit load” system is therefore the most suitable for handling. To increase efficiency, it is necessary to follow a standard ISO rule, to adopt a standard pallet size<sup>4)</sup> and

<sup>4)</sup>A standard pallet following the ISO rule has the size of 1100×1100 mm<sup>2</sup> for Asia, 1000×1200 mm<sup>2</sup> for Asia and Europe, 1219×1016 mm<sup>2</sup> for North America. Using the standard pallets can increase working speed, ease of confirmation on the quantities of the goods, possibility to work with forklifts, and maximizing the utilization of the storage space.



package the product so that it is adapted to this standard pallet. In addition, simulation results have shown that a significant reduction in operation times can be achieved by using a unit load system instead of manual handling (Wisetjindawat et al. 2014).

- **Resource management.** In the case that the receiver country does not possess sufficient equipment, vehicles, or skilled staff, the donor countries should be prepared to supply such resources. Considering the recent increase in the frequency of disasters, a system to share resources among many countries will be very useful.

#### 5) *To increase the work efficiency using Information Technology*

Donors should inform the recipient authority of the proposed goods before delivery. A standard form for invoicing and for other related documents in electronic format is suggested to reduce unnecessary workload in the crisis period.

After the recipients of the goods receive the information, they will be able to prepare the work procedures, and assign the fleets and equipment before the arrival of the goods. A simple excel sheet may be enough for recording and managing the goods. These processes can help to increase the efficiency of the operations.

## 5.2 Logistics During the Restoration Period

After the situation calms down, the needs of victims will increase in variety as they start to restore the quality of life of survivors. Logistics during this period becomes more complicated. The characteristics of goods during this period are:

- Increased variety of items and of packages while the lot sizes reduce.
- Decreased level of emergency.
- Increase in number of donors.

The main issue for logistics in this period is to deal with wide variety of goods and packaging in contrast to the survival period. We suggest improving the efficiency of logistics during the restoration period by:

#### 1) *Controlling the incoming goods and utilizing business warehouses*

In general, the donors during the restoration period can be classified into two types: group donors (eg. companies) and individual donors. Goods received from companies generally come in similar packaging and large lot sizes. These goods are rather easy to handle.

However, these goods alone will not normally suffice to provide for the individual needs of survivors. On the other hand, goods from individual donors come in smaller lot sizes and vary in packaging. These goods can generally respond well to the individual needs of victims, but they require considerable time to handle the wide variety of goods. It is important to consider the characteristic of the goods from both types of donors and find an appropriate logistics to deal with each type.

In the aftermath of the 2011 Great East Japan Earthquake, 2,140 types of good were recorded as the goods flowed through a primary stockyard in Miyagi prefecture (Japan Warehousing Association 2012). In fact, this number is not excessive for a general business company. Therefore, a business warehouse can be very useful for the operation. Considering the resources owned by the logistics sector in technologically advanced countries (eg. equipment, hardware, and warehouse management systems (WMS)), such a large number of goods types can be easily handled.

As stated previously, the storage of survival goods and other goods should be separated. When receiving goods for the restoration period, the goods can be stored at a designated business warehouse. From there, the donated goods can be properly distributed to match the needs of individual victims and of a shelter. This can reduce the problem of sending unwanted goods to victims and uneven distribution.

Depending on the level of damage, the number of warehouses might be increased. However, the number should be carefully chosen as too many of these warehouses could lead to inefficiencies.

## *2) Gathering information on the needs of victims*

In general, distributing goods to victims by volunteers is preferable. During the survival period, supplying goods by mechanical means is acceptable, however, when the variation in needs increases, volunteers can better interact with and provide moral support to victims. Therefore, it is suggested to use volunteers to obtain information on the needs of victims in the restoration phase. Volunteers can also help to receive feedback on the service and can better understand the needs of victims.

## *3) Improving efficiency of the management*

It is better to manage all donated goods properly by assigning management codes, recording the goods, and deciding the storage locations. For a smooth operation, it is recommended to use an invoice system which records the goods information. In case of goods received from companies, invoice and codes are generally attached already to the package and the goods usually come with pallets. The palletized goods can be managed easily with a normal logistics system.

In case of goods from individual donors, goods come in several package types without pallets and without product codes, and often many types of goods come together in a single box. Therefore, when receiving such goods, staff should manage to assign goods codes, record them, and decide their storage locations.

Instead of sending each individually donated package directly to the affected region, the goods should be first gathered at donation centers in unaffected locations. For the non-palletized goods, these goods will need to pass an additional process for unpacking, categorizing, registering, and managing their storage. A good example is the work done in Shizuoka Prefecture where the city collected several goods donated from citizens at a designated location and performed several processes before sending the categorized goods to the affected region (Shizuoka City Homepage 2013). The structure of goods flows is suggested as shown in Figure 4. With this system, the goods will not arrive at shelters mixed together in the same box as often happened in the past and can be stored directly at a warehouse without an additional effort to categorize the different types of goods.

### **5.3 Increasing Efficiency of the Operation**

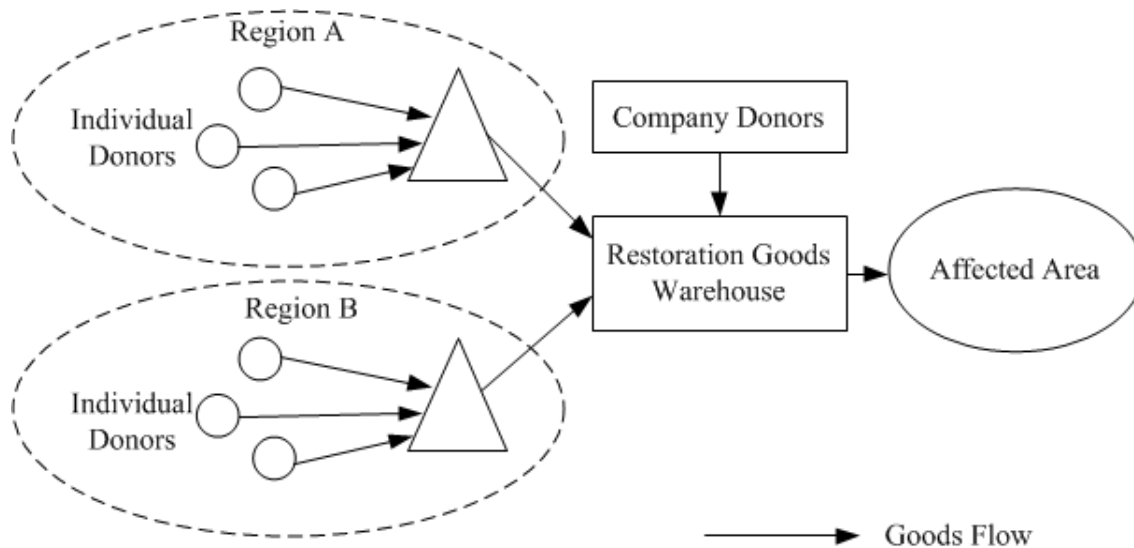
As the suggested plan will use business warehouses for distributing the relief goods, it is necessary to consider methods to reduce workloads at the warehouses.

#### *1) Prediction of the needs and preparation of the goods sets in advance*

There are some goods that are generally necessary for most victims. When victims move to temporary housing, daily items such as shampoos and utensils become necessary. Other goods are specific to certain groups. For example, children will require school supplies upon returning to school. Not all victims will require the same goods, hence the lot size of the goods to be delivered becomes smaller than during the survival period. In addition, company donors, who provide most of the donated goods, normally donate their own products, in relatively generous quantities. It is feasible to prepare goods sets once the quantity

is large enough to make sufficient numbers of the goods sets.

To deal with these goods, it is suggested to prepare and group the necessary items into a set for each specific purpose and for each type of victim (such as a stationary set which may contain pencils, eraser, notebooks, etc.). The preparation should be performed outside the affected region and be ready to be distributed to victims at the appropriate time. We should avoid distributing each of the goods separately to victims. Normally, such grouped packages of goods will be useful for most victims. Therefore, preparation and storage of these goods sets (such as utensil sets, washing sets, stationary sets, etc.) before a disaster occurs will be very helpful.



**Figure 4.** Dealing with goods donated from citizens

After a disaster occurs, normally such goods will be donated again. It is suggested not to send the goods directly to the shelters but instead to send the goods to the goods-set warehouses outside the affected region, facilitating the preparation of goods into sets before being supplied to victims. This procedure can avoid sending unwanted goods to the victims.

Moreover, these goods are not required immediately after the disaster. Preparation and storage of these sets should occur outside the affected region awaiting their distribution at the appropriate time, in the correct quantities, to the right shelters. This can help to reduce problems of overwhelmed storage facilities at shelters and stockyards.

In summary, to achieve a successful logistics for dealing with the goods sets, we need to prepare: 1) guidelines for the composition of the goods set, 2) facilities for storage of these goods, 3) after a disaster strikes, the necessary quantities should be ascertained before sending goods to shelters, 4) the sets should be sent only once the goods have been requested or the need has been determined, and 5) as these goods are normally required in small lot sizes, a simple excel spreadsheet can manage the goods storage.

## 2) *Avoiding the reception of unwanted goods*

Goods donated from companies normally come in large lot sizes and are not difficult to handle. However, unwanted goods are sometimes donated. In some cases donations by firms are made due to the companies' selfish economic interests such as in order to clear the storage of their unwanted products or

to reduce tax liabilities. In such cases, the goods donated by companies come with invoices. From the invoice information, we can easily trace the goods' origin. If the company is found to have sent unwanted goods, it can be identified, and future unwanted donations can be forestalled, or the goods can be sent back when this is the most convenient option for the smooth operation of the relief effort.

In order to reduce such problems, especially for foodstuffs, there should be a rule to decide the minimum duration before expiration of goods eligible for donation. Regarding food products, normally the manufactured and/or expiration dates are displayed. This information should be required, and should be provided electronically to the relevant authorities upon donation.

## 6. ESTABLISHING COORDINATION WITH THE LOGISTICS SECTORS

Normally, the government will be responsible for most of the work of distributing the goods to victims. However, under a disaster situation, government cannot easily prepare enough staff to deal with the sudden heavy workload. Also, most staff normally have little knowledge and experience in logistics. Hence, it is suggested to establish coordination between the government, NGOs, and the logistics sectors. In detail, our suggestions are:

- For the distribution of survival goods, experienced staff will significantly improve the efficiency. We suggest preparing contact with the logistics sector in advance and allowing the logistics companies to take full responsibility for the distribution work when a disaster occurs.
- For the restoration-period goods, the warehouses for these goods should be capable of dealing with numerous types of goods. In addition, these warehouses should facilitate the involvement of volunteers and NGOs in the delivery of material goods as this can aide their provision of important moral support to victims. On the other hand, the efficiency of operation will be improved with the involvement of the logistics sector when identifying the proper location and the operation methods. Furthermore, it is suggested that, as the restoration phase begins, the government should support the operation costs of the warehouses and allows NGOs to take responsibility for the warehouses while receiving technical supports from the logistics sector.
- Warehouses for the storage of goods sets need to be prepared in advance, before a disaster occurs. In general, many items are commonly required by most victims. In the Japanese case, NGOs, who normally received goods donated by companies, can prepare the goods sets ready to be distributed when required. We suggest the government allowing NGOs to take responsibility of these warehouses as well.

## 7. CONCLUSION

To avoid a second disaster due to inappropriate relief goods management, it is necessary to design a proper logistics to reduce the flows of unwanted goods and respond to the variety of victims' needs. To improve operations, two types of logistics are suggested: logistics for survival periods and for restoration periods.

1. *Logistics during the survival period:* the goods required are generally the same everywhere. As time is the most critical issue during this period, the logistics should be able to provide a continuous flow of goods in a short time. To achieve this logistics, we suggest that the government and international organizations should establish a standard system for storage of the relief goods. When a disaster occurs, the locations of warehouses for transshipment of the survival goods should be identified in close proximity to the affected region. The operation should be a mixture of push and pull logistics in

which the goods types are treated in a push manner to reduce delay while the management of the delivery in terms of quantity, time, and location should be in a pull manner in order to prevent blockages caused by unused goods along the supply chain. In order to shorten the operation time, standard codes and pallets would be useful. Also, import problems from foreign countries should be addressed in advance. It is suggested also to allow the logistics companies to take full responsibility of the operations, under supervision of the government.

2. *Logistics during the restoration period:* the logistics during this period should be able to deal with a wide variety of goods. When a disaster occurs, all non-survival goods should be gathered in a separate warehouse and distributed when needed by victims. This method can reduce the problem of uneven distribution. However, the workloads of these warehouses are rather large. It is necessary to consider methods to reduce these workloads. Goods donated by companies are normally palletized and come in large lot sizes; but these goods cannot always respond to all the needs of victims. On the other hand, goods donated from individual donors, come in small lot sizes, and can sometimes better respond to specific needs of victims; but these goods requires more handling. Therefore, the goods from individual donors are suggested to be gathered at each donating region and later sent to the affected area after the goods are categorized, repackaged, and/or palletized. It is also important to consider a system to control the donation of unwanted goods. In addition, it is suggested where possible to facilitate the provision of goods and assessment of the needs of victims by volunteers in order to support victims spiritually through conversations and activities. The NGOs should be able to take responsibility for the operation of these warehouses with support provided by the logistics sectors.
3. *Goods-sets warehouses:* based on previous experience, many goods are commonly required by most victims. These goods can be prepared in advance in the form of goods sets to serve specific purposes. The efficiency of this operation can be improved using logistics technology. Warehouses for storage and preparation of these goods sets should be identified in advance before a disaster occurs. The operations of such warehouses in Japan are suggested to be taken mainly by NGOs with support from the government and the logistics sectors.

These suggestions can help to ensure a smooth operation. To provide the goods to victims efficiently requires logistics which include the operation, warehousing, equipment, and information systems altogether.

So far, this paper has presents some ideas to improve the operational efficiency of the humanitarian logistics in the aftermath of a large-scale disaster. These ideas are derived based on the authors' long experiences in commercial and humanitarian logistics in Japan in an attempt to address the problems encountered in previous disasters. A quantitative validation of the proposed methods through a simulation tool is envisaged. An assessment of their application in a real operation after a disaster would provide the decisive test of our ideas. This paper focuses on the Japanese situation and its recommendations are hence most relevant to Japan. Most of the issues discussed are relevant to disaster logistics in other countries though many of the recommendation may need to be altered to fit local circumstances. Finally, the knowledge and resources owned by the private sector are very precious and a successful cooperation between the public and private sectors will improve the efficiency of disaster relief operations.

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