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DECISION SUPPORT IN EMERGENCY PREPAREDNESS – REQUIREMENTS FOR A NETWORK OF EMERGENCY RESPONSE FACILITIES IN INDONESIA

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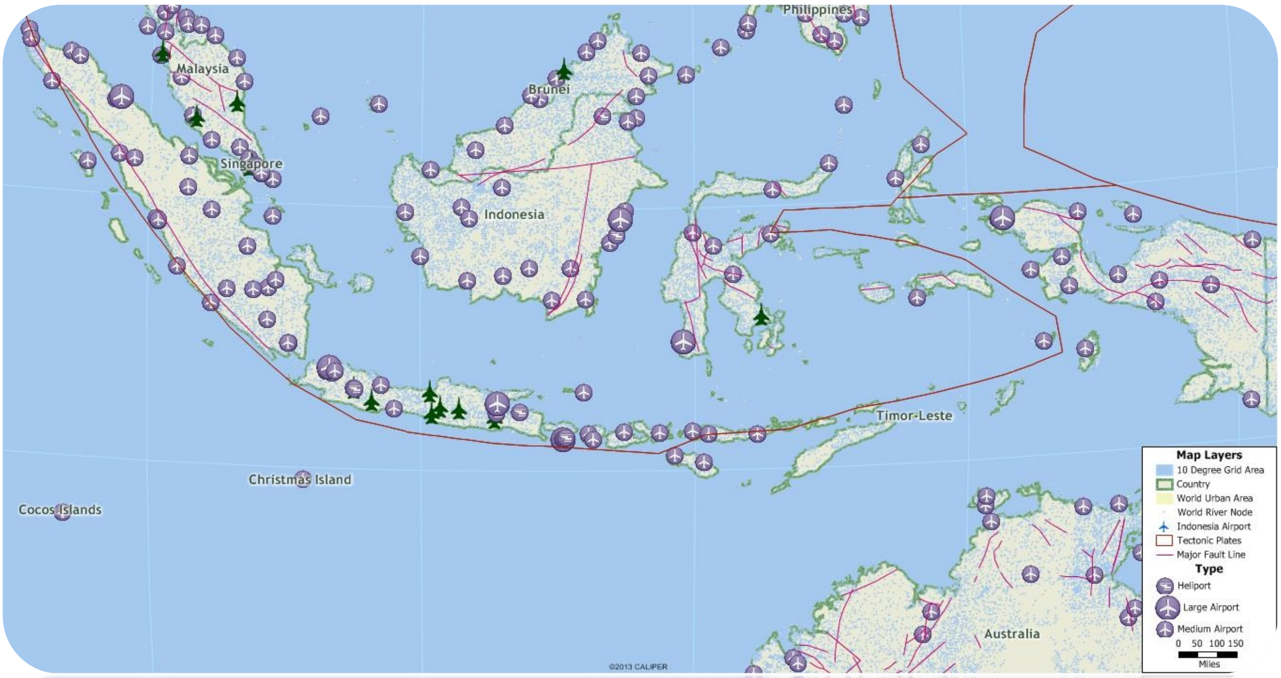

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Executive Summary

This whitepaper discusses challenges and opportunities of using pre-positioned strategic stockpiles as a logistics preparedness practice to reduce disaster risk and improve disaster response efficiency in heavily disasters impacted countries in ASEAN region. More specifically, this whitepaper focuses on two of the main challenges faced by decision makers in the design phase of a network of emergency response facilities – 1) determination of optimal network size (number of warehouses) and 2) identification of facility locations.

This piece of work also presents a discussion of the approach and methodology identified to support an exploratory study for establishing a network of strategic stockpiles in Indonesia, which is considered as one of the world's most disaster prone countries. The framework discussed in this whitepaper has been designed to be extendable and applicable to any country of ASEAN region, and the aforementioned case of Indonesia represents only a pilot study. The findings of this research will be of interest to decision-makers of National Disasters Management Office (NDMO) as this methodology is capable of assisting them in making effective and efficient decisions related with facility location and stock-prepositioning.

Introduction

Due to number of factors such as climate change, unplanned urbanization, subsequent struggles for distribution of resources, etc., it has been predicted that the number of humanitarian crisis, both man-made and natural, will rise continuously during the coming decades. The multitude of stakeholders present in those crises, the mass deployment of goods and personnel, and the specific nature of the financial flows will lead to the emergence of complex supply networks with unique restrictions (Blecken, 2010). Ranging from small localized events (e.g. Pakistan's recurrent floods, cyclones in the Philippines, Bangladesh and Myanmar, etc.), to major catastrophes (e.g. 2011 Japan earthquake and tsunami, 2004 Indian Ocean tsunami etc.), Asia has one of the most incidences of reported disasters and highest reported number of victims. Within Asia, the Pacific region is considered one of the most disasters prone areas (OCHA, 2015). According to the latest report by UN ESCAP, during the past decade, the region was stricken by 4,625 disasters – over 40% of the global total – claiming the lives of nearly half million people (UN ESCAP, 2015).

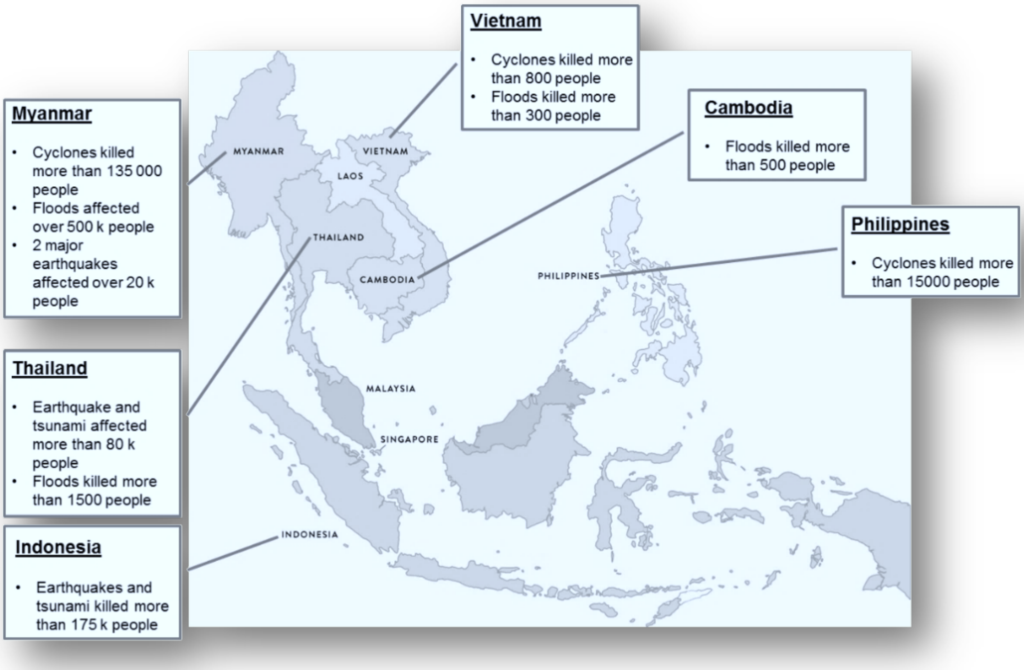

FIGURE 1. Humanitarian response (major events) in Asia-Pacific (2002-2015)
SOURCE: self-illustration based on (Guha-Sapir, Hoyois, & Below, 2015)

The trends in the number and impact of disasters, and the massive scale of recent global relief efforts have brought growing attention to the need for effective and efficient disaster relief operations.

The objective of disaster response in the humanitarian supply chain is to provide relief (emergency food, water, medicine, shelter, supplies etc.) to affected areas by emergencies, to minimize human suffering (Beamon, 2004). Therefore, the design and operation of relief supply chain play a key role in achieving an effective and efficient response. Although only recently, the humanitarian community began to recognize logistics as one of most critical factors significantly affecting the success of disaster relief operations (Van Wassenhove, 2006) – from resource planning, procurement, delivery and storage of critical disaster products to its last mile transportation and distribution. In terms of humanitarian supply chain management, organizations are nowadays facing new challenges in the delivery of relief items, some of which are linked to the sheer increase in the needs of the affected populations, others to the changes in the environment in which they operate, while others to the increased expectations of compliance to donors and accountability to beneficiaries (Rafter, 2012). Relief organizations are faced with a unique blend of challenges characterizing the relief chain design and management, such as unpredictability of demand, suddenly-occurring big scale demand and short lead times for a wide range of supplies, lack of resources such as supply, people, technology, transportation capacity and money (Balcik & Beamon, 2008). This is further complicated by unpredictable factors such wild urbanization, big climate change, big political, social and economic change and communication technology and innovations in information. Hence, relief organizations and governments need to engage in preparatory activities that enhance their logistics capabilities when responding to emergency.

Lessons learnt from previous worldwide large scale emergency responses indicate that pre-positioning critical relief supplies in strategic locations can be an effective strategy to increase robustness and resiliency of humanitarian supply chains. Facility location decisions affect the performance of relief operations, since the number of locations of the distribution centers (DCs) and the amount of relief supply stocks held will significantly impact on both speed of response and its sustainability (Balcik & Beamon, 2008).

In this exploratory study, we discuss facility location and stock pre-positioning decisions making processes in a humanitarian relief chain, focusing on challenges and opportunities particular to ASEAN region. This will provide an analytical approach to assist decision-makers in making effective and efficient facility location and stock-prepositioning decisions.

The rest of this whitepaper focuses on the advantages of pre-positioning strategic stockpiles for enhancing efficiency of disaster relief operations are discussed. Then, we discuss two of the main challenges faced by decision makers at embryonal stage of the design of a network of emergency response facilities: definition of optimal network size (how many nodes) and identification of most appropriate locations for the DCs. Each of the challenges is presented with a problem description, a solution approach, and some initial results from research to date. Finally, we present the approach and the methodology identified to support an exploratory study for establishing a network of emergency response facilities in Indonesia.

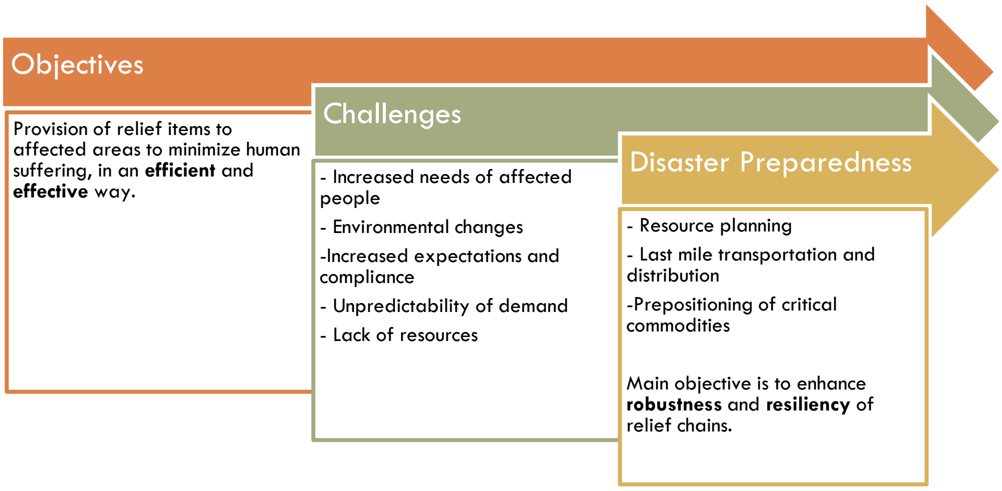

FIGURE 2. Humanitarian Supply Chain: Objectives, Challenges and Preparedness Activities

Efficiency of Disaster Relief Operation: Pre-Positioning Strategic Stockpiles

Responses to previous big scale emergencies indicate that pre-positioning critical relief supplies in strategic locations can be an effective strategy to improve the capacities in delivering sufficient relief aid within a relatively short timeframe, including improvement of logistics infrastructures and processes.

Besides covering the basic function of safeguarding relief commodities (e.g. to be used in the immediate aftermath of a disaster), these emergency response facilities will be capable of providing further supporting needful services such as handling and consolidation of humanitarian cargo for distribution of relief goods in the disaster affected areas. The main functional benefits provided by an established network of DCs include:

- Improvement of capacity of governments (through their National Disaster Management Agencies, if any) and all humanitarian actors to respond to emergencies in a timely and cost-effective manner;
- Enablement of timely and coordinated receipt and dispatch of relief assistance via air, sea and surface transport;
- Improvement of the immediate availability of relief items (e.g. emergency food, water, medicine, shelter etc.), eliminating else needed long lead times for the mobilization of resources, and minimizing potential risk of supply disruptions, increasing the overall resilience of the disaster relief supply chain;
- Enhancement of capacity building to support operations of repackaging;
- Establishment of practical training venues for logistics stakeholders and emergency responders;
- Reduction of operational costs.

CHALLENGE I – What Is The Optimal Size Of A Network Of Emergency Response Facilities In a Heavily Disasters Impacted Country In ASEAN?

Problem Description: When a major disaster hits, governments and relief organizations may experience relief chains disruptions if preparedness initiatives to increase robustness of relief supply chains are not undertaken. In this context, pre-positioning of critical relief supplies in strategic locations is considered as one of the most effective preparedness strategies. Decisions making on DCs network sizing (optimal number of warehouses) has a significant impact on sustainability and speed of humanitarian logistics operations. Thus, it is valuable for relevant stakeholders to determine appropriately the number of DCs composing the network of emergency response facilities as this has an integral relation with logistics costs related with humanitarian operations.

Solution Approach: To overcome the limitations of traditional Decision Support System (DSS) tools designed to tackle similar problems, but targeted mainly at private sector entities, we developed an innovative methodology taking into account both speed of operations and economic affordability:

- Given a set of in-country probable large scale disasters scenarios, the first objective of the network size optimization problem encompasses the demand coverage component through the minimization of the total distribution cost constrained over maximum distance between the emergency response facilities and their assigned potentially affected areas- demand point.

- In order to merge responsiveness and economic affordability, efficient distribution strategies that reduce logistics cost are required to be taken into account. This comprises several factors such as transportation costs, warehouse operating cost, and more importantly, warehouse-retailers echelon inventory replenishment cost. Minimizing the total distribution cost function will support the decision making in terms of optimal number of warehouses.

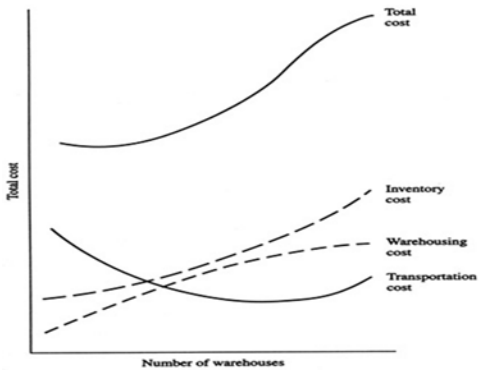

FIGURE 3. Impact of number of distribution centers on logistics cost
SOURCE. (U.S Department of Trasportation, Federal Highway Administration, 2015)

Expected Outcome: The methodology will support the determination of the optimal number of warehouses to compose a network of emergency response facilities. It also covers aspects related with optimal inventory policies aiming at minimization of response time.

CHALLENGE II – How To Identify The Most Appropriate Locations For Establishing An Efficient Network Of Emergency Response Facilities?

Problem Description: In the series of problems to consider in the decision making process concerning emergency logistics preparedness, the determination of the most appropriate locations for the DCs composing a network of emergency response facilities can be considered a key activity, given its significant impact on effectiveness and efficiency of disasters relief operations. Thus, it is critical for National Disaster Management Agencies and relief organizations to optimally determine the locations for their emergency response facilities, as this has an integral relation with the security and protection of the society.

Solution Approach: To overcome the limitations of traditional approaches on tackling multi-criteria supply chain decision making, we developed an innovative framework for addressing the location problem for a network of emergency response facilities. Geographic Information System (GIS) technology is used to integrate key information such as National Master Plan for the Economic Development, natural disaster hazard zones, population densities, strategic logistics infrastructure, and industrial cluster. The combination of this information with inputs of local logistics experts will enable the identification of candidate locations to further investigate. Then several location criteria are considered and relatively weighted, leading to a hierarchical structure of the previously-identified location candidates.

FIGURE 4. GIS platform showing several layers of key logistics infrastructures for Indonesia
SOURCE: Screenshot from Maptitude Mapping Software

Expected Outcome: Several layer of information both quantitative and qualitative in nature are integrated into a mapping platform, and key logistics information such as shortest paths and routings, flows of relief items, drive time or distance rings can be produced and visualized. This platform will eventually enable to pre-assess the performances of relief operations, while allowing to compare several network setups to identify the optimum that will guarantee maximum speed of response and its economic affordability (given a set of constraints)

Case Study: Indonesian National Network Of Emergency Response Facilities

PROJECT BACKGROUND

Indonesia is the world's largest archipelago with a population of over 252 million people spread out across some 18,000 islands. Located at the intersection of three tectonic plates, Indonesia is one of the world's most disaster prone countries; having more than 500 volcanoes (128 of which are active) and more earthquakes per year than any other country on earth, where much of this activity is offshore bringing the added risk of tsunamis. Additionally flash floods, mudslides, forest fires, disease outbreaks, and droughts cause civilian casualties, population displacement, loss livelihoods, property destruction and environmental damage. This high frequency of severe disasters is accompanied by an associated risk of catastrophic natural disasters of a scale necessitating system-wide ('Level 3') international humanitarian response.

In Indonesian's Medium-Term Development Plan (RPJMN) 2015 – 19 the Government of Indonesia has made a highly commendable commitment to "Develop Logistics Capacity and Distribution Management during Disaster occurrence, through establishing Logistics Humanitarian Hubs on each Island, which are reachable to support a post disaster occurrence in remote areas."

These assurances pertain to a highly laudable venture aimed at saving lives and alleviating the suffering caused by natural disasters and is based upon well-established best practices for emergency preparedness through the strategic prepositioning of emergency stockpiles in appropriate localities.

This move in-itself can significantly enhance BNPB (Indonesian National Board for Disaster Management – Bahasa Indonesia: Badan Nasional Penanggulangan Bencana) capacities to reach populations affected by natural disasters, herein UN WFP proposes a supporting package of technical assistance projects which will ensure that the logistics hubs themselves are effectively developed and managed utilizing state of the art systems for data analysis identifying the most strategic locations, warehouse management, commodity tracking and operational procedures (during both emergency and normal situations).

In the worst case scenario, excellent facilities and assets which are ineffectively operated (due to lack of appropriate management systems and trained staff for example) can do more to hinder than help during an emergency response. Consequently, UN WFP proposes to ensure that these facilities adopt the highest standards for operational management and support systems in order to safeguard the functional operability and indeed protect the significant investment to which the Government funds are devoted.

The overarching approaches are focused creating independent sustainability through ensuring BNPB possess sufficient internal capabilities both for effective operational implementation and to training their own staff to the same high standards. The successful development of innovative modernistic solutions benchmarked equivalent international projects adopting cutting edge technologies operated by skilled personnel and supported by in house training competencies is a vision which will endow BNPB with a distinguished renown for prominent levels of emergency preparedness.

PROGRAMME COMPONENTS

The overarching programme is best presented through a series of constituent components each of which directly align to UN WFP comparative advantages benefiting from decades of international experience and lessons learnt from responding to emergencies:

1. Emergency Response Planning
2. Physical Facility Development
3. Supply Chain Management Systems
4. Dedicated Training Programmes

1. Emergency Response Planning

Operational planning is a critical aspect of emergency preparedness, and would develop the government's response capabilities for disaster scenarios through enhanced preparedness levels. Key advantages include enhanced timeliness, appropriateness and efficiency of local, national and international humanitarian emergency response in Indonesia through:

- Strengthened government leadership in response planning;
- Improved coordination between provincial, national and international agencies via joint planning for emergency logistics activation, including logistical hubs and transport corridors;
- Identification of gaps in sub-national and national response capacities;
- Joint work planning at provincial and national levels to address prioritised gaps;
- Response options analysis delineating pre-agreed modalities of in-kind food, cash or voucher assistance to be rendered in the event of large-scale emergencies, activation procedures and delivery mechanisms.

The scenario-based Concepts of Operations (CONOPS) delineates air, sea and land-transport corridors and logistics hubs to receive and consolidate international humanitarian assistance and provides a detailed yet flexible plan for international support to the national response scenario. Furthermore this planning tool addresses multi-stakeholder requirements and involves stipulating multi modal transportation and defines a series of key operational infrastructures.

The establishment of these Humanitarian Response Facilities provides a key opportunity to enhance logistics coordination (clearly essential for effective responses) by enabling the initiation of regional logistics clusters within their respective coverage areas.

2. Physical Facility Development

Essentially this project is an initiative of the Government of Indonesia (supported by UN WFP); therefore all activities related to procurement (of land, construction services, etc.) and realization of construction would be conducted using standard process and procedures in line with their standard financial and procurement systems etc. UN WFP can however provide technical assistance within the design and planning aspects.

The expertise within UN WFP HQ Engineering Unit possess a wealth of technical experience in functional design and construction of large scale hubs for humanitarian requirements providing oversight and expertise throughout a series of specific phases, including:

I. Definition of technical requirements and project scope
II. Compilation of technical specifications for architect blueprints
III. Ensuring suitability of functional designs

3. *Supply Chain Management Systems*

The ability to provide supplies quickly and cost effectively can be a considerable challenge in an emergency operation; detailed up to date accurate data on locations and details of available stockpiles and completed distributions is the basic requirement to enable operational implementation. It will be essential to ensure that these components are seamlessly integrated within an overarching Supply Chain Management system in order to ensure synchronization from the initial procurement through to the final distribution point.

Similarly, it is also vital to ensure that full details for the practical application of these Standard Operations Procedures are comprehensively incorporated into dedicated training modules.

Three key components are identified as essential for the effective streamlining and delivery of humanitarian aid during an emergency response:

I. Commodity Tracking Systems
II. Inventory Management Systems
III. Warehouse Management Systems

4. *Dedicated Training Programmes*

The sustainability and application of the Emergency Response Facility operations and emergency responses will be achieved through a dedicated, comprehensive and customized training programme applying to all equipment, facilities, technical, operational, procedural applications established herein. This should include the organization of regular Simulation Exercises, to test the systems, procedures, facilities, and SOPs developed under this project.

The design and implementation of this training curriculum focuses specifically on ensuring effective operability and sustainability of the aforementioned facilities; furthermore strategic level training programmes emphasize disaster response logistics and humanitarian supply chain management. The facilities themselves provide additional opportunity to greatly enhance the effectiveness of training implementation through direct practical application within the facility whilst being specifically designed to support the overarching Supply Chain Management systems and interrelated SOPs.

Outcomes from delivery of the customized training programmes would further enhance direct synergies from simulation exercises and on the job tuition and direct application of content during regular operations within the Emergency Response Facility. The particular training schemes target various profiles and levels of emergency responders within government and non-government humanitarian agencies increasing familiarity with the national level response plans and capacities; this approach significantly contributes to better vertical integration and coordination of the overall response capacity of the government.

NETWORK OF EMERGENCY RESPONSE FACILITITIES DESIGN: DETERMINATION OF MOST APPROPRIATE LOCATIONS FOR THE LOGISTICS HUBS – THE RESEARCH METHODOLOGY

Inspired by the need for improving the national disaster response capacity, and by rationale of "establishing Logistics Humanitarian Hubs on each Island", the first challenge is to address concerns on the determination of most appropriate locations for pre-positioning those strategic facilities[1] across the country.

To tackle this challenge gap, as mentioned earlier, in this study will combine technologies and tools such as Geographic Information System (GIS) technology and Analytical Hierarchy Process (AHP).

First iteration to identify the list of suitable localities for the hubs, key information needed is; i) Indonesian Master Plan for the Economic Development, ii) Natural disaster hazard zones, iii) Population densities[2], iv) Strategic logistics infrastructure (airports[3], heliports, ports, highways, railways), and v) Industrial cluster, are integrated through a GIS platform (examples see figures 5 and 6).

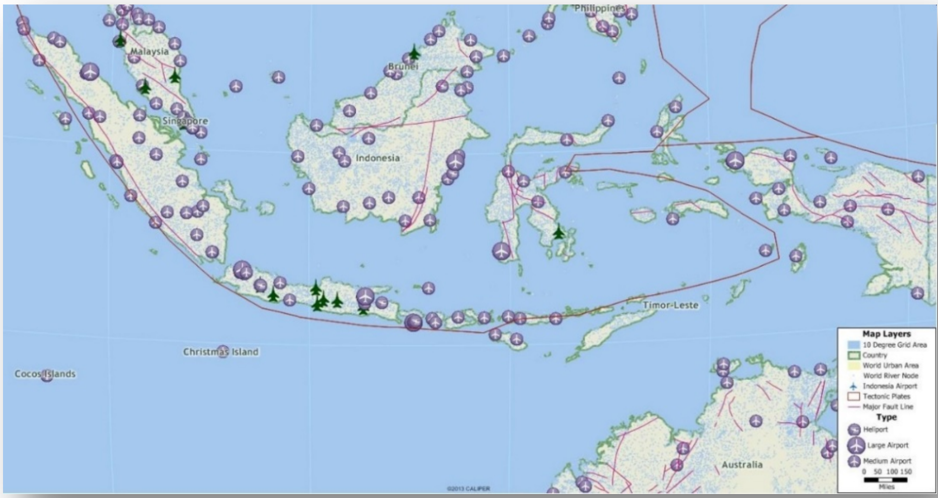

FIGURE 5. GIS platform allows to overlap information on key operational infrastructure (e.g. airports –civil and military), tectonic plates and fault lines
SOURCE: Screenshot from Maptitude Mapping Software

[1] See table 2, page 13 for a detailed list of relief items to be stocked in the DCs
[2] Also considering rings of population around the main volcanoes of the country
[3] In consistent with the GARD (Get Airports Ready for Disasters) programme (United Nations Development Programme, 2012) launched by the Indonesian government, Deutsche Post DHL and United Nations Development Programme (UNDP)

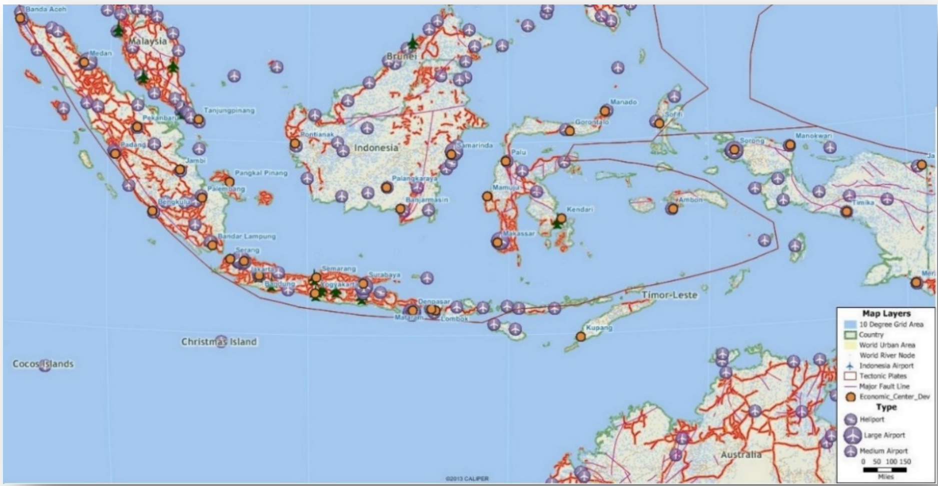

FIGURE 6. GIS platform allows to overlap information on key operational infrastructure (e.g. airports –civil and military, and highways), tectonic plates, and fault lines, and data concerning the Master Plan for the Economic Development of Indonesia
SOURCE: Screenshot from Maptitude Mapping Software

Next, the application of Analytical Hierarchy Process (AHP) will support the definition of a hierarchical structure of the identified localities based on location criteria and their weightage.

Throughout the various phases of this research work, the support of practitioners will be needed. Semi-structure interviews will be conducted with supply chain experts to identify potential locations for the logistics hubs based on experience, but also to validate, classify, and rank warehouse selection attributes (see table 1 for the list and description of location decision criteria).

AHP (analytical hierarchy process) is a multi-criteria decision-making tool widely used for applications related with engineering sciences. The tool has been successfully applied to a wide range of complex industrial engineering problems whose final decision is based on the evaluation of a number of alternatives in terms of a number of criteria. The method is proved to provide the advantage of permitting a hierarchical structure of the criteria (which can be expressed in different units or the pertinent data are difficult to be quantified). In other words, AHP process makes it possible to determine the relative importance of a set of attributes for humanitarian warehouse location, incorporating judgements on intangible qualitative criteria alongside with tangible quantitative criteria

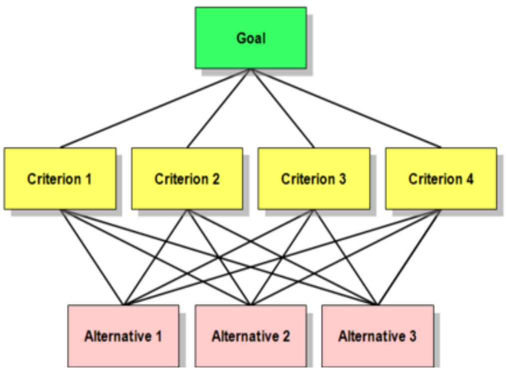

TABLE 1. Sample of warehouse location selection attributes defined through available literature and semi-sctructured interview with practictioners

Serial No.	Criterion	Description
C1	Coverage	The geographical coverage for each hub based on travel time to reach disaster affected populations. This involves combining geographic population distribution with hazard zones.
C2	Access to affected zones	Lead time to reach the affected populations.
C3	Risk	HRFs should be outside of identified hazard zones (Exclusion criteria)
C4	Access to infrastructure	Access to suitable infrastructure for transport (air, sea, land), with suitable operational capacities including storage, transportation assets, commercial service providers and mechanical handling equipment's.
C5	Access to Corridor	The need for the HRF to be located within one of the major transportation corridors as pre-identified by the Indonesian Government
C6	Congestion	Heavily congested facilities (port, airports) and corresponding road access is a negative or exclusion criteria
C7	Costs	Transportation costs for resupplying HRFs and running operations from the respective locations (includes sending goods from the hub to affected areas).
C8	National development plan (NDP)	Proximity to Economic Centres identified in the National Master Plan for the Acceleration and Expansion of Indonesia -Economic Development 2011-2025, which includes expansion of logistics infrastructure to support the economic activities

In terms of operations execution, it is worth to note that during the push phase of the emergency response (typically before – for predictable events - or at the immediate aftermath), air operations are prioritized due to their high speed. Helicopters are the key transportation mode, although its usage level needs to be balanced with economic factor (cost efficiency), and limitations on range and cargo capacities. However, in view of Indonesia's unique geographic structure, being an archipelago of about 18,000 islands, the access to some of the remote islands communities is only possible through maritime distributions (e.g. in eastern Indonesia). In this scenario, efficiency of relief operations is significantly impacted by the effectiveness of operations of identification - through the use of Automatic Identification System (AID) - of available fleet (ships) ready to be deployed to disaster zones.

STATUS OF RESEARCH UP TO DATE

At this stage of the research, the cities of Jakarta, Makassar and Medan have been identified as potential locations for locating three out of the required six logistics hubs. However, further analysis need to be undertaken to prove the suitability of these localities, as well as further locations need to be identified and analytically assessed.

Designed to guarantee an uninterrupted flow of relief goods to disaster affected areas in times of disasters, table 2 contains the key categories of relief items to be supplied –and then stocked – for disaster response purposes. Considering the main hazard threatening the archipelago are earthquakes, tsunamis, landslides, volcanoes eruptions, floods, and droughts, categories of relief goods to pre-position will be related to i) food items, ii) non-food items (NFI), iii) hygiene items, iv) tropical disease control, v) technical accessories, and vi) administrative items (see table 2 for detailed analysis). Specialized medical equipment and supplies are not considered at this stage of the analysis, as the Supply Chain design will be included in a latter phase of this exploratory research work.

TABLE 2. Sample of Relief Items Categories for Indonesia

Type No.	Type	Description
T1	Food Items	▪ Food (Rice, High Energy Biscuits, powder milk, canned food…)[4]; ▪ Water (bottles);
T2	Non Food Items	▪ Shelter (tents, blankets, sleeping bags, makeshift beds, sleeping mats); ▪ Clothing (e.g. raincoats, warm clothes…);
T3	Non Food Items	▪ Masks; ▪ Sanitary goods (Temporary toilets, heavy rubber gloves, soap, detergent, napkins, tissues, toothbrushes, toothpaste, toilet rolls, towels...); ▪ Body bags;
T4	Tropical disease control (if applicable)	▪ Protection from mosquitoes (mosquito nets, repellent); ▪ Items for destroying larvae and adult mosquitoes;
T5	Technical Accessories	▪ Electricity generators; ▪ Water purification appliances; ▪ Heating appliances (kerosene heaters); ▪ Flashlights ; ▪ Fuel (Diesel oil, gasoline, kerosene);
T6	Administrative items	▪ Printers, copy & fax machine; ▪ Chairs; ▪ Desks; ▪ Personal Computers ; ▪ Light vehicles;

[4] Further key food items distributed as part of food packages / food baskets here not included

Conclusions

In this white paper, we have presented two main challenges faced in the designing phase of a network of emergency response facilities aiming at increasing robustness and resiliency of emergency supply chains, and identified well versed approach to address these challenges. These challenges have arisen from a grand set of many other challenges that will be in turn addressed. Work is ongoing. However, in this initial phase of the study, we especially invite collaboration from leading institutions of the humanitarian community in ASEAN region such as UN OCHA and AHA Centre. This would elevate the strategic impact of this study, which ultimately aims to reinforce the architecture of the humanitarian response through a well-coordinated framework within which all humanitarian stakeholders can significantly contribute.

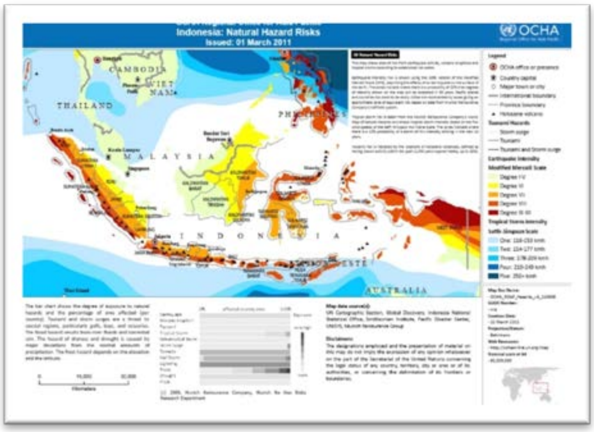

FIGURE 7. Natural hazard risks in ASEAN

Source. *UN OCHA*

FIGURE 8. AHA presence across ASEAN

Source. *AHA Centre*

After completing this exploratory study of tackling the design of a network of Distribution Centers, further 5 challenges will be investigated, including:

- **Challenge 3** – How to mitigate emergency supply chain nodes vulnerabilities and risk of network failure through redundancy of emergency response facilities?
- **Challenge 4** – How will the business community be affected by a major calamity? The importance of understanding the future risk of infrastructure failure to enhance business recovery
- **Challenge 5** - Can a national network of emergency response facilities be designed to respond beyond national boundaries?
- **Challenge 6** - Can a national network of emergency response facilities be designed to serve the business community during peaceful times?
- **Challenge 7** – Can shared capacity policies in the Pacific region be implemented?

Future Developments

Future developments of this research work include the disaster response phase, rather than in this initial facility location identification, and regard economic considerations upon relief operations, digital connectivity for the enhancement of effectiveness and efficiency of disasters response, and design of micro distribution.

While at the immediate aftermath of the emergency the overarching optimization criterion considered as the base of all analysis is "maximum speed" of relief operations, in the next stage of rehabilitation, reconstruction, recovery and prevention, other concerns might include the "minimization of cost" of overall relief activity. In such a trade-off situation, determining the best locations for DCs would be very sensitive to commodities, mode of transport, supply chain network, infrastructure conditions and disaster prone areas. To serve the decision making process on determining potential locations of logistics hubs in Indonesia, in a later stage it would be appropriate to compare alternative location optimization methods, and evaluate those against a comprehensive list of humanitarian response objectives. This analysis will involve a set of simulations which might be performed as a further development of the current facility location study. This exercise will generate new knowledge, deep the understanding of the problem, and provide evidence to support decision on investing for building further DCs (in other locations), which most likely will be located not only within the Indonesian borders, but also within Asia Pacific region.

With concern of digital connectivity (accessibility to phone and internet connection), this is a basic service which nowadays is required to be guaranteed, especially from the disaster management standpoint. For operators, this is an enabler of smoother operations, and the use of crowdsourcing platforms (e.g. social media such as Twitter) could be instrumental to gather and spread information to make the planning and execution work. The use of real-time information from social media in times of disasters to support emergency response management has been recently explored, and the research highlights its significant contribution to emergency response activities. In the ASEAN region, there is a high potential to explore the application of such approach to disaster management, for example through the combination of mobile phone activity data and remote sensing data to understand communications and mobility in the aftermath of the event. Previous studies conducted in a flood scenario (Mexico, state of Tabasco, 2009) showed that the patterns of mobile activity in affected locations during and after the floods could be used as indicators of (1) flooding impact on infrastructure and population and (2) public awareness of the disaster.

With concern of design of micro distribution, this is a pillar activity which should be included within the package of logistics preparedness activities especially in the view of its potential to enhance significantly efficiency and effectiveness of response operations to a major event. It becomes then essential to include this practice within the national framework for multi-sectoral international humanitarian cooperation for Indonesia. GIS platforms can offer a significant support for this through the identification and mapping of points for local dispatching (e.g. convenient shops, mosques etc.), offering a robust support for micro distribution planning (e.g. up to city level).

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