Disaster Management Capacity Building at Airports and Seaports

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Abstract (used only on Springer website, not in chapter)

Ports – i.e., airports and seaports – are the main points of entry through which foreign intervention delivers aid into a country that is affected by a disaster. Affected countries are often developing nations, where transport infrastructure is limited and disaster management capacity is considerably lower than in industrialized countries. When developing countries' ports suffer direct damage from a disaster or their processes are unable to handle the increased flow of needed goods in an effective and efficient manner, humanitarian aid delivery is delayed and disaster recovery is slowed down. Various initiatives from the public and private sectors (including public-private partnerships) aim to make ports in developing countries better mitigate and manage adverse effects that originate from disasters, so that relief goods reach their destination earlier and at a lower cost, while supporting the country's economic development and recovery; this chapter introduces and compares such initiatives. Handling all ports at risk, which are at least dozens and arguably more than a hundred, exceeds the capacity of existing initiatives. So that more ports may benefit from disaster management capacity building, this chapter also introduces relevant knowledge from supply chain risk management that may be investigated more deeply and applied by individual companies, professional associations, aid organizations or governments to set up new initiatives or to improve existing initiatives. Finally, propose new concepts at the frontline of addressing these issues.

Introduction

Humanitarian logistics is "the process of planning, implementing and controlling the efficient, cost-effective flow and storage of goods, materials and equipment as well as related information, from point of origin to point of consumption for the purpose of meeting the beneficiary's requirements" (Blecken 2010). Ports – i.e., airports and seaports – are essential for this process, because they are the main points of entry through which foreign intervention delivers aid into a country that is affected by a disaster, and often they are bottlenecks.

Most of the affected countries are developing nations, where transport infrastructure is limited and disaster management capacity is considerably lower than in industrialized countries (Smith et al. 2013). When developing countries' ports suffer direct damage from a disaster or their processes are unable to handle the increased flow of needed goods in an effective and efficient manner, humanitarian aid delivery is delayed and disaster recovery is slowed down.

Examples of ports that have been directly damaged by disasters but have been essential to humanitarian aid and economic recovery include Louis Armstrong New Orleans International Airport subsequent to Hurricane Katrina in 2005, Toussaint Louverture International Airport and the seaport at Port-au-Prince after the Haitian Earthquake of 2010, and the airports and seaports in the central Philippines after the 2013 typhoon. Examples of ports that have been overwhelmed or nearly overwhelmed by nearby or distant disasters that depending on those ports for humanitarian logistics are Maputo International Airport after flooding in Mozambique in 2000, Bandaranaike Colombo International Airport in Sri Lanka after the 2004 Indian Ocean Tsunami, and the seaports of East Africa for famine relief for South Sudan since 2011. These were all competent ports that would have been able to handle normal demands but experienced low performance caused by physical damage, disrupted workforces, or unaccustomed amounts and types of service demands. Additionally, there are many small and medium seaports, especially on Africa's west coast, that are hardly mentioned in reports about humanitarian aid, because aid organizations choose not to use them due to low expectations regarding performance or reliability.

Are Airports and Seaports Similar Enough to Fit a Single Approach?

There are substantial differences between airports and seaports. For instance, seaports need much higher investments into infrastructure to be operational. Can airports and seaports really be treated under the umbrella of port preparedness? Certainly there is no one-size-fits-all approach. However, the overlap between independently developed methodologies for airports and seaports suggest that despite all differences, there are many similarities too. To begin understanding these,

we present the results from a comparative analysis of airports and seaports. Understanding further similarities requires us to dive more deeply into the initiatives from practice that improve port preparedness.

How is port preparedness improved in practice?

In recent years, organizations from public and private sectors (including public-private partnerships) came to realize the importance of ports for humanitarian logistics and the issues that ports face. In 2009, the first initiative that gained worldwide recognition for addressing such issues was Deutsche Post DHL's "Get Airports Ready for Disaster" (GARD). GARD helps regional airports and local communities to increase their disaster management capacities and has helped seven airports through the end of 2013. In 2013, AmericasRelief Team's Port Resiliency Program (PReP) joined the stage by completing its first pilot project at an airport in the Dominican Republic. PReP targets both airports and seaports in the Latin American and Caribbean (LAC) region. In 2013, BVL International's Humanitarian Logistics Council (HLC) presented its concept "Get Seaports Ready for Disaster" (GSRD) to the public. GSRD targets African seaports and has yet to be field-tested with a pilot project. These three programs represent the totality of the current state of practice, which are at the forefront of improving disaster management at critical transport infrastructure locations – an area that gains attention not only in practice, but also in print (see e.g. Levy and Bissell 2013). Later in this paper, we shall present these initiatives individually and in greater detail. To understand how these initiatives work and how they might be improved, we then turn to supply chain risk management.

What can be gained from supply chain risk management?

"Any threat to the reliability of the transportation network constitutes a vulnerable spot, a weakness in the supply chain" (Husdal 2009a). Supply chain risk management investigates the negative effects of such threats. It also advises how to prepare for them and how to manage them when they become real. We present several pertinent (humanitarian) supply chain risks and introduce approaches to manage them, thereby referring to port preparedness in practice. The approaches include the ISO 31010 risk management process and risk management strategy development. Following the ISO 31010 risk management process requires the identification, analysis and response to risks, which are inherently difficult. We thus examine some of the difficulties. Eventually we present the Mission Dependency Index as a field-tested, practical metric and methodology to identify critical facilities at ports.

How may disaster-related port issues be addressed in the future?

Supply chain risk management has only been subject to research for three decades and has received considerable attention only for about 15 years, which makes it a very young field from an academic perspective (Husdal 2009a, Vanany et al. 2009). Similarly, its practical application to ports by the presented initiatives is very young, with only one of the initiatives (GARD) having progressed beyond its pilot stage. In such an early stage of development, it is difficult to project into the future. However, there are several options for addressing port-related issues in disaster management. We point out some of those, including the next steps for the presented initiatives, the idea of port certification, and the possibility of a "white fleet" as a flexible means of mitigating bottlenecks at points of entry.

Similarities and Differences between Airports and Seaports

There are many differences between airports and seaports, and there are also many similarities. Before examining the presented initiatives in greater detail, it is necessary to point out what these differences and similarities are.

This paper is based on the premise that programs to make airports and seaports more effective after disasters can be based on a single set of principles and basic procedures. To some, this may not be obvious. Historically, airport managers and users see their facilities as being unique with little in common with other types of facilities and activities, even ones in the transportation sector. Seaport managers and users take a similar view. Emergency managers and risk managers see the similarities while being aware of the differences. Table 1 compares airports and seaports across many dimensions that may matter regarding port preparedness, showing that the similarities outweigh the differences.

Table 1. Comparison of Airports and Seaports for Complexity related to Resiliency

Dimension of Complexity	Airports	Seaports
Iconic nature of port	Often seen as emblem of city, viewed romantically; seen as economic engine	Rarely iconic, viewed as industrial facility; seen as economic engine
Intensity of regulation	Intensely regulated by aviation and security agencies (federal and/or international)	Less intensely regulated but often subject to stringent environmental regulations
Number of regulators	Relatively few	Relatively few but probably more that are directly involved with seaports than is case with airports
Ownership	Usually publicly owned but often leased to private operators, especially outside the U.S.	Usually publicly owned but often leased to private operators

Dimension of Complexity	Airports	Seaports
Complexity of ownership	Usually a single owner of an airport, perhaps tempered by leases or ownership of portions of terminals	May be a single owner, multiple owners, or different owners of parts of the seaport such as piers
Complexity of governance	Simple at a given airport but a wide range of types of governance	Perhaps more complex than for airports, but also with a wide range of types of governance
Number of operators on site	Usually the owner operates or just one operating company at an airport, terminals at an airport may have different operators	May have more than one operator
Number of operators using site	Usually a relatively small number. Airports range from one airline to over 120 airlines and one to dozens of air cargo companies, depending on size of market	Usually a relatively large number with a very wide range of size of operations, probably less dependent on size of market
Number of tenants and concessionaires	Typically many in order to serve needs of passengers with trend towards master contracts for whole airport	Relatively few, as customer service to passengers is usually not an issue even at cruise ship terminals
Political sensitivity	High, especially when publicly owned	High, especially when publicly owned
Sensitivity to short-term profitability	Extreme	Less extreme
Length of planning horizon	Most airports redo their master plans every 7-10 years with small updates in the interim	Most seaports grow incrementally without master planning
Intensity of pressure to hold down operating expenses from users	Extreme because of competition with other airports and pressure from airlines over rates and charges	Possibly less extreme. Ports often viewed as legitimate subsidy of other economic activities.
Cost of fixed infrastructure (replacement cost of typical port)	On order of US$100 million to US$10 billion	On order of US$100 million to US$10 billion
Cost of movable infrastructure	Perhaps $1/10^{th}$ cost of seaport's single most expensive movable infrastructure (cargo crane compared to jetway)	Perhaps 10x cost of airport's single most expensive movable infrastructure (cargo crane compared to jetway)
Cost to implement "soft resiliency" measures[1]	Similar to seaports	Similar to airports
Intermodal connectivity	Less than seaport although trend is towards greater intermodal	More to much more than airport

[1] "Soft resiliency" measures refer to changes to policies, procedures, operations, personnel protection, relation-ships, plans, and movable equipment; in other words, everything except major physical infrastructure modifications.

Dimension of Complexity	Airports	Seaports
	connections, especially for major hub airports; large role for automobiles	
Insurability	Continued operation is proof that airports are insurable.	Continued operation is proof that seaports are insurable.
Dependency on outside services (e.g., air traffic control, dredging, electricity, water, sewer)	Absolute but probably less self-aware of dependency than most seaports	Absolute and probably more self-aware of dependency that most airports
Vulnerability to weather	More vulnerable	Less vulnerable but still vulnerable
Vulnerability to flooding	Relatively small but some airports are on flood plains or at low elevations near shorelines	Relatively high because all ports are on flood plains and/or shorelines
Vulnerability to climate change	Less vulnerable	Highly vulnerable to sea level rise
Vulnerability to geotechnical disasters	Highly vulnerable in seismic zones, aircraft movements can be disrupted severely by damage to runways, taxiways, aprons, towers, lighting, and avionic systems	Highly vulnerable in seismic zones, but ship movement less disrupted in aftermath
Vulnerability to terrorism	Vulnerable, but threats probably have greater effect on public perception	Vulnerable, but threats probably have less effect on public perception
Vulnerability to civil war	Vulnerable	Vulnerable
Vulnerability to labor disputes	Vulnerable	Vulnerable
Vulnerability to disruption at other ports in network	Extremely vulnerable due to airline scheduling and routing	Much less vulnerable
Effect of level of development of country	Each airport may be more important in less developed countries with fewer airports	Each seaport may be more important in less developed countries that typically have fewer seaports
Vulnerability to disruption by disaster in region that does not directly hurt port	Immediate vulnerability extreme as competing users try to use airport, which may have diminished capacity	Longer term vulnerability as incoming aid requiring ability to handle heavier loads (ship-sized vs. plane-sized) will arrive days or weeks later
Time to repair	Relatively shorter—benchmark is time to remove damaged aircraft on runway	Relatively longer, perhaps—benchmark is time to remove sunken ship in channel

Current initiatives

Various initiatives from the public and private sectors aim to make ports in developing countries more resilient and allow them to perform better, so that relief goods reach their destination earlier and at a lower cost, while supporting the country's economic development and recovery; this chapter introduces and compares these initiatives.

Get Airports Ready for Disaster (GARD)

DHL's corporate citizenship program sought to improve the ability of humanitarian organizations and agencies to respond to disasters more quickly by preparing airports to resist damage from natural disasters and to recover more quickly from any damage that cannot be prevented (UN 2014, DPDHL 2014). In partnership with the United Nations Disaster Program, DHL devised GARD and tested it at two Indonesian airports in 2009. By the end of 2013, GARD has been applied to a total of seven airports or clusters of neighboring airports. GARD was also applied at one seaport although the program is primarily designed for airports.

GARD helps airports and communities during disaster-free times by

- Reviewing airport capabilities and capacities
- Understanding coordination requirements
- Training local people (train-the-trainer concept)
- Helping to formulate a contingency plan and a coordination structure (UN 2014).

GARD is intended to be global in scope. In 2003, DHL put three Disaster Response Teams (DRTs) in place to implement the program: DRT Americas in Panama, DRT Middle East/Africa in Dubai, and DRT Asia Pacific in Singapore. The lessons learned by these teams responding to earthquakes, hurricanes, cyclones, and typhoons between 2003 and 2009 were applied in the development of GARD (DPDHL 2014). One goal of GARD is to make the DRTs more effective after a disaster.

GARD works closely with the United Nations Development Programme (UNDP) and with nations. DHL first obtains a formal commitment from the host nation to the airport that will receive GARD services, and each GARD service delivery ends with a formal, written acknowledgement by the airport, national agencies, and any other parties that participated in the steps taken and the results. Table 2 gives an example of a typical GARD training.

Table 2. Example of a typical GARD training (Meier 2011)

Day	Location	Curriculum
1	Classroom	Establish need/Focus on methodology

		• Post disaster simulation exercise • Discussion with UN, NGOs and DHL Disaster Response Team (DRT) on disaster management scenarios. Introduction to GARD & familiarization with the GARD assessment method. • Airport disaster management processes and communications • Detailed analysis of flow, ground handling and outflow management • Discussion of challenges, constraints, facility requirements, processes
2	Field	Apply learnings • Process brief and review of assessment tools/templates • Interview with key airport personnel • On-site airport capacity assessment (inside) • On-site airport capacity assessment (outside)
3	Classroom/Field	Apply learnings/coaching • Finalize on-site assessment • Summary and analysis of airport assessment findings • Begin developing standard operating procedures (SOPs)
4	Classroom	Coaching/Refine results • Presentation of recommended SOPs • Feedback, coaching, further evaluation • Refinement of contingency plan
5	Classroom	Ensure follow-up • Review and wrap-up • Certification ceremony

Get Seaports Ready for Disaster (GSRD)

Inspired by the need to improve port performance in East Africa to support humanitarian relief in South Sudan and by the example of GARD, BVL International's Humanitarian Logistics Council developed the concept for "Get Seaports Ready for Disaster" (GSRD) (Möhring & Link 2013). The primary goal of GSRD is "to increase disaster preparedness in seaports, particularly increasing performance and accelerating the processing of incoming relief goods." The focus is on improving the speed and efficiency of cargo handling and therefore a port's throughput capacity.

GSRD's procedures closely follow the GARD model with emphasis on preparedness, training, train-the-trainer, and other resiliency measures not involving changes to physical infrastructure. The basic structure of GSRD has six phases:

1. Kick-off with seaport and key stakeholders
2. Assessment of structures and processes
3. Analysis of assessment results
4. Training
5. Evaluation
6. Workshop to recapitulate and reinforce the results of phases 1-5.

As noted by Möhring and Link (2013), there are several critical success factors for GSRD:

- Seaports that are adequately developed in physical terms must be selected to receive the performance and resiliency enhancing services of GSRD.
- The seaport must be operational before the new training can be effective at creating change.
- The initial focus must be on the handling of goods within the port although GSRD should be aware of hinterland issues and intermodal connectivity issues.
- Local stakeholders must be aware of the need for and possibility of performance improvement as a result of implementing GSRD at the port.
- GSRD needs strong partners, such as intergovernmental organizations, to leverage and mobilize efforts for the first four success factors.

GSRD is still under development and expects to run its first pilot project at an African port during 2014.

Port Resiliency Program (PReP)

The Port Resiliency Program (PReP) is an initiative of the humanitarian nongovernmental organization (NGO) AmericasRelief Team (ART). PReP grew directly out of ART's experience in brokering free air and sea transport for relief and recovery activities by other NGOs in response to the Haiti Earthquake of 2010. It seeks to apply the lessons learned in Haiti and from hurricanes, particularly Hurricane Katrina in 2005, to make ports—airports and seaports—more resilient (Babun & Smith 2013). PReP's goals are to improve ports' ability to speed humanitarian assistance, to quicken ports' return to normal commercial activities, and to reconcile the competing humanitarian and commercial demands on a damaged or recovering port.

PReP seeks to teach ports how to apply soft resiliency measures to existing organizations and physical facilities to optimize their resistance to damage from natural and manmade disasters and to speed the ports' recovery. The program's basic structure has four phases:

1. Guided self-analysis and outside expert analysis of plans, equipment, and capability of port
2. Workshop at ART with port's stakeholders to validate the results of phase 1, identify gaps, and develop plan for targeted training
3. On-site delivery of the targeted training and a table top exercise to evaluate the effectiveness of the training and the port's overall resiliency
4. Aftercare to ensure follow-up.

PReP was developed during 2012 and a pilot project was done with Las Americas International Airport in Santo Domingo, Dominican Republic, during October 2012 through February 2013. In the process, specific gaps were identified in the areas of protection of essential employees and their families, pre-contracting for services to reopen the airport, alternative communications methods for disasters, and interagency relationships, and customized training was delivered in each of these areas and evaluated as effective. The after action review of the pilot project suggested a number of improvements to PReP that have since been incorporated into the program.

As with GSRD, a number of success factors have been identified. The single most important ones are

- Involvement of the right stakeholders throughout the process. This especially includes the national agencies for transportation, security, emergency management, and law enforcement as well as the tenants and users of the port.
- Solutions built by improving existing plans, procedures, and relationships
- Respect for the client port and its stakeholders

PReP's pilot project was funded by a grant from FedEx. PReP is now seeking to develop a model by which each port and perhaps its stakeholders will pay for all or most of the cost, which is estimated at US$55,000-70,000.

Comparison of Initiatives

GARD, GSRD, and PReP have major similarities and significant differences. A comparative analysis can suggest underlying principles and perhaps gaps, both of which are necessary if a fully optimized approach to port preparedness is to be achieved. Table 3 presents the characteristics of the three programs dimension by dimension.

Table 3. Comparison of Existing Programs

Program	Getting Airports Ready for Disasters	Get Seaports Ready for Disasters	Port Resiliency Program
Acronym	GARD	GSRD	PReP

Program	Getting Airports Ready for Disasters	Get Seaports Ready for Disasters	Port Resiliency Program
Organization	DHL	BVL International & the University of Münster	AmericasRelief Team
Type of port(s) served	Airports	Seaports	Airports and seaports
Geographic area served	World	Africa	Latin America and Caribbean
Mission	Addresses risks at airports in disaster prone areas before crises occur	Increase performance of seaports	Increase resiliency of ports
	…in order to…	…in order to…	…in order to…
Goals / objectives	Improve level of disaster prevention at airports in areas of high risk of disasters	Improve level of disaster prevention at seaports in areas of high risk of disasters	Speed up humanitarian aid
	Bring disaster related authorities and experts together	Bring disaster related authorities and experts together	Speed up return to normal commercial operations to promote economic recovery
	Enable participants to assess the surge capacity of their airport and to develop an action plan	Enable participants to assess the surge capacity of their seaport and to develop an action plan	Reconcile competing users at recovering port
Element(s) used	Policy	Policy	Policy
	Procedure	Procedure	Procedure
	Organizational	Organizational	Organizational
	Relationships	Relationships	Relationships
	Operations	Operations	Operations
	Movable equipment	Movable equipment	Movable equipment
	Not major infrastructure	Not major infrastructure	Not major infrastructure
National agency prior approval	Yes	Will probably be sought	Yes
Trigger mechanism	UNDP request/suggestion; request by airport; joint decision between DP DHL and UNDP	UN, nation, or port requests GSRD	Port requests PReP service
Primary contact point to initiate program	UNDP country office/via UN contacts	UN agency or nation	Individual airport or seaport contacts PReP
Major stakeholders	DP DHL, UNDP/UNOCHA, Airport, government, country based NGO's, aid organizations, disaster management agencies national police, different	Seaport, national agencies (regulatory, infrastructure, emergency management, law enforcement, military), aid organizations	Port, companies using port, port tenants, national agencies (regulatory, infrastructure, emergency management, law enforcement, military)

Program	Getting Airports Ready for Disasters	Get Seaports Ready for Disasters	Port Resiliency Program
	national government departments/agencies		
Other stakeholders	National Airlines	Disaster victims, companies using port, port tenants, passengers, shippers, local governments	Passengers, shippers, disaster victims, aid organizations, local governments
Starting point / baseline	Disaster Management Theory followed by Airport Assessment, (Creating awareness on the importance of disaster preparedness at airports by assessing the airport)	Review of seaport capabilities and capacities	Self-evaluation and outside expert evaluation of disaster plans, policies, risks, and preparedness; gap analysis of these materials in consultation with major stakeholders
Type of training provided	Standard Program that will be tailored individually, depending on national/airport circumstances	Customized training tailored to gaps and delivered on-site by GSRD team	Customized training tailored to gaps and delivered on-site by PReP team
Source of trainers / instructors	DHL aviation experts	Shipping companies, aid organizations, national and local agencies	Volunteers from other airports and emergency agencies, but eventually from alumni of training program
Drills used in program	None	None	None
Exercises used in program	Interactive group exercises, airport assessment, report writing	Interactive group exercises, seaport assessment, report writing	Table top exercise used as “graduation” to evaluate effectiveness of training and to identify remaining or additional gaps
Highest level organization approving or endorsing program	Airport authorities/ Government	Seaport authorities/ Government	ART, requesting port, and participating stakeholders, by consensus
Means of recognizing completion	Participant Certificate and Surge Capacity Report	Certificate of completion for participants (perhaps stating achievements since last training)	Unofficial diploma
Repeat frequency	Core program: one-time only; trained local instructors remain at port; Recently developed follow-up workshop “GARD plus”	Core program: one-time only; follow-up workshops every 6-12 months	Two to three years recommended by pilot test participants
Formal certification of resiliency	No	No	No but planned

Program	Getting Airports Ready for Disasters	Get Seaports Ready for Disasters	Port Resiliency Program
Program recognized by insurers / reinsurers	No	No	Being sought
Estimated cost per port	Not reported	Not reported	US$55,000-70,000
Funding method or source	Sponsored by UNDP and DPDHL, national in-kind contributions	Development funded by BVL International; funding for program execution is under investigation	By cash grants from FedEx and in-kind donation of services and transportation from several donors; now attempting to shift to beneficiary port pays for service

Examination of Table 3 reveals that there is very strong agreement among the programs on most programmatic elements. The similarity between GARD and GSRD is expected since GSRD was inspired by GARD and developed with the cooperation of DHL's GARD team. However, GARD and PReP were developed in complete isolation from each other, so the congruency between GARD and PReP is particularly convincing. The most important elements for which there is agreement are

- Clarity of mission, which is to make ports of either kind more capable after a disaster
- A focus on speeding humanitarian aid and the resumption of normal commercial activities at the port
- Close collaboration with national and local agencies
- Close collaboration with aid organizations
- A relatively short-term orientation that seeks quick, relatively inexpensive fixes through "soft resiliency" measures rather than through major physical infrastructure changes
- Insistence on the involvement of a broad range of stakeholders in all phases of the program
- Emphasis on careful review and analysis of initial state of a port and the port's existing capabilities
- Transfer of outside expertise to local persons by train-the-trainer, hands-on training, mentoring, and follow-up activities
- Focus on gaps in capabilities and preparedness
- Substantial capability to produce verifiable documentation that could support a formal certification program
- An unstable funding mechanism. This weakness is shared by all three programs.

The similarities strongly suggest traits that should characterize a globally applicable port resiliency program. In contrast, the differences among the programs indi-

Comment [DL1]: Is this statement correct from a GARD perspective? GARD is a vital part of DHL's GoHelp initiative and the company's CSR strategy after all. Funding is indeed a huge issue; if GARD is exempt, we w revise the sentence to make this very clear.

cate potential cross-fertilization that could lead to improvements in all three programs. Areas where there are major differences among GARD, GSRD, and PReP are

- Whether national level approval and formal agreement is required prior to program initiation at a port
- Type of entity leading or managing effort
- Relationship to international agencies
- Top-down direction vs. bottom-up request for service
- Role of volunteer instructors
- Types of exercises used
- Highest level organization endorsing, approving or authorizing program
- Methods used to follow-up after initial service by program
- Means of recognizing completion
- Repeat frequency
- Means of recognizing completion
- Nature of documentation
- Evaluation of surge capacity and production of surge capacity report

Lastly, there are three areas for which none of the three programs has found a sure-fire solution:

- Means of motivating ports to enhance their resiliency
- Relationship to insurance
- Funding mechanisms

What does consideration of the existing programs and their differences tell us? The most important conclusion is that the existing programs cannot handle enough ports—airports and seaports--per year to prepare to handle humanitarian aid in the parts of the world where natural and manmade disasters are most likely, much less globally. The answer is to use what works in the programs to create an overarching initiative that will create a reliable, replicable, scalable, and cost-effective method of making any port prepared for the adverse effects of disasters. In order to do this, choices need to be made among the options presented by differences among the programs. GARD and PReP have initiated a cooperative effort to understand each other's detailed procedures with a goal of improving each program. This increased understanding along with greater experience as GARD and PReP do additional ports and GSRD does its pilot project will help make informed choices among these options.

Eventually, a serious effort must be made to find solutions for the problem areas of motivation, creation of insurance or other benefits, and stable funding mechanisms or models.

Airports and seaports are critical nodes in nearly every supply chain involved in humanitarian aid after disasters. Even when rail, highway, or canal transport can be used, air transport will almost always bring the first response and assessment teams. When heavy or bulk materials are needed for long-term relief, recovery, and rebuilding, sea transport will be necessary even when the disaster may be

inland from the seaports. For these reasons, port resiliency and preparedness measures are intimately related to supply chain risk management.

Taking a Supply Chain Risk Management Perspective

As noted in the introduction, supply chain risk management investigates how adverse events in supply chain operations negatively affect one or more performance measures in the supply chain with negative effects for the firm under consideration, advises how to prepare for such events and how to manage them when they occur (Hofmann et al. 2013, Sodhi et al. 2012). Rather than talking about "adverse events in supply chain operations", it is much simpler to call them disruptions (when they occur) or risks (before they occur) (Rao and Goldsby 2009)[2]. Disruptions may fall into various categories[3] and may generally be attributed to cause or location.

Causes for disruptions may lie in poor quality or damaged goods, missed or late deliveries, unexpected increases to supply costs, longer lead times or supply capacity constraints (Minahan 2005). Humanitarian supply chains are not exempt from this, as shown by the "USAID | DELIVER PROJECT task order for procurement and distribution of essential public health supplies", which identified several categories themselves, including events and metrics for the events, as shown in Table 4.

Table 4. Risk Categories, Events, and Metrics for Risk Performance Monitoring (USAID 2013)

Risk category	Event	Metric
Product registration	Product not registered in time	Percentage of countries that could not ship due to registration errors
	Product shipped but not allowed in-country	
Mission ordering and expectations	Missions do not understand how to plan supply and submit orders correctly, within a reasonable time.	Mission orders for more than 1 product for next year?
		Percentage of emergency orders
Supplier performance	Supplier has production problems.	Percentage of supplies released by supplier within 7 business days of goods available date

[2] According to Hofmann et al. (2013), this distinction is not universally applied in the literature, so you will find various terms being used synonymously for risk, like hazard, uncertainty, peril or exposure. For the sake of simplicity, we adopted the terms disruption and risk exclusively for this chapter.

[3] Category systems for disruptions are given in, e.g., Chopra and Sodhi 2004 or Bogataj and Bogataj 2007.

	Products do not meet quality standards.	Lot acceptance rate
	Supplier requests a product recall.	Number of recalls in a specific period
Funding	Funds not available when needed for procurement actions.	
	Missions do not provide adequate funding for orders.	
Forecasting and production planning	Unable to fulfill unplanned orders because of insufficient data to support good forecasting.	Planned orders as a % of actual orders
Inventory and stock levels (stocked items)	Inventory falls below optimal levels for several consecutive months.	Percentage of products in inventory >15% of forecasted demand
Freight forwarding	A. Shipments are not delivered on time because of shipper error.	Delivery to Plan (DTP) reasons for late shipment (% with this reason)
	B. Pre-clearance process documents not received in time to clear shipment.	DTP reason for late shipment (% with this reason)
Quality assurance	A. Product is received that does not meet quality specifications.	Lot acceptance rate
	B. Testing lead time effects on-time deliveries.	DTP testing ≤ 4 wks. (% with this reason)
Warehousing	Warehouse does not manage inventory properly for storage or pick and pack.	DTP warehouse metric (% with this reason)

Product registration, freight forwarding and warehousing are also key activities at ports. Quality assurance may be an issue too, for instance if rice sacks are not properly stored and become wet; inventory and stock levels (stocked items) are relevant if the port is used for long-term storage, which is generally not desirable from a supply chain perspective but happens in practice (Möhring and Link 2013).

When focusing on the location of disruptions, transportation networks become an interesting subject, with several studies relating to ports (see e.g. Bloetscher et al. 2013, Boucher and Guimond 2012, McLaughlin et al. 2011). Considering the socio-economic relevance of ports, this is hardly surprising. It may indeed be surprising, however, that empirical evidence suggests low risk awareness in the maritime industry (Berle et al. 2011). If it is the same in the aviation industry, awareness has to rise before port preparedness can reach its full potential.

Robustness, Flexibility/Agility and Resilience

The terms robustness, resilience, flexibility and agility often occur in relation to supply chain risk management. To clarify their meaning, Husdal (2009a, 2009b) attempted to distinguish them, based on various existing definitions, as follows.

- **Robustness** is the ability to accommodate any uncertain future events or unexpected developments such that the initially desired future state can still be reached. In other words, it refers to the ability to endure changes without adapting.
- **Flexibility/Agility** is the ability to defer, abandon, expand, or contract any investment towards the desired goal. In other words, it is the inherent capability to modify a current direction to accommodate and successfully adapt to changes in the environment.
- **Resilience** is the ability of a system to return to its original state or move to a new desirable state after being disturbed. In other words, it is the ability to survive changes despite severe impact.

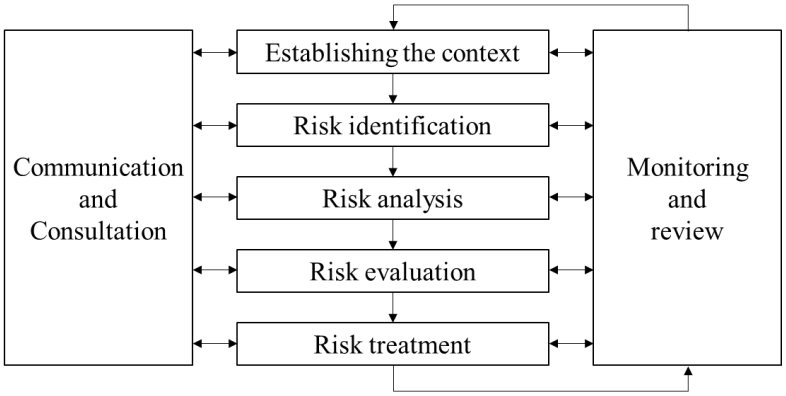
If a seaport sustainably increases its performance, its ability to deal with demand spikes increases, whether the spikes originate from a disaster or from any other disruptive event. In this light, GSRD mainly aims to make seaports more robust and flexible. This is also because it focuses on seaports that are not directly hit by a disaster. In contrast, GARD and PReP mainly aim at making ports more resilient, so that they would remain operational and continue their business despite taking severe damage. GSRD does also improve resiliency, but more as a side-effect from improving disruption management (Bhamra et al. 2011). GARD applies a combination of robustness and flexibility/agility in its attentiveness to the evaluation and documentation of an airport's surge capacity, where surge capacity is the ability of an airport to handle the extra operations, passengers, and cargo generated by disaster relief and recovery. Resiliency is an implied component of surge capacity as lack of resiliency would degrade an airport's surge capacity. This surge capacity perspective may be implicit in PReP's attempt to reconcile the competing uses of humanitarian relief and the resumption of normal commercial activities at a port, but it is not clear in PReP's documentation.

The ISO 31010 Risk Management Process

As Jereb et al. (2011) point out, there currently is no standard for holistic supply chain risk management, which exemplifies the remaining gap between research and practice. To bridge this gap, we follow their approach insofar that we base our elaborations on a standard that does exist and comes fairly close: the ISO 31010 risk management process[4].

[4] Jereb et al. (2011) combined the ISO 31010 risk management process with the ISO 28000 international standard on security in supply chains in an online tool to support risk assessment. The tool is available online at: http://labinf.fl.uni-mb.si/risk-catalog/. Jereb et al. focus on risk assessment because they identified it as the single most important activity in the risk management process. ISO 28000

Fig. 1. The ISO 31010 Risk Management Process (ISO 2009)



Examination of Table 3 and our analysis of it shows that the three existing programs—GARD, GSRD, and PReP—incorporate all seven activities in the ISO 31010 risk management process, that is, the contents of all seven boxes in Figure 1. This indicates that a systematic risk management process can be applied to airports and seaports.

In practice, the process is not as simple as it looks on paper. As noted by Meixell and Norbis (2011), supply chain risk management approaches are already difficult to manage in stable environments and even more so in challenging situations, such as economic crises or natural and man-made disasters. Furthermore, special attention is required when ocean carriage is required with the passage of containers through seaports. The approaches presented in this chapter should thus be taken with care and not assumed to immediately work when applied out-of-the-box. To make the best use of them, it is necessary to develop a sound risk strategy.

Establishing the Context through Strategy Development

In many countries, the board of directors of public companies can be held responsible for risks that are taken in their company (see e.g. the UK's Companies Act 2006). Waters (2011) thus advises top-level company leadership to

- Define the organization's attitude towards risk, its philosophy and the strategic direction of risk management;

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offers categories to hold risks, e.g. natural environmental events (storm, floods, etc.), which may render security measures and equipment ineffective. We do not pick up the ISO 31000 and ISO 28000 families in greater detail here but encourage readers to examine them in the light of this chapter.

- Create an appropriate environment for risk management, with necessary systems and resources;
- Publish risk management policies defining attitudes, approaches and responsibilities;
- Know about significant risks that the organization faces;
- Understand the potential consequences of these risks for stakeholders;
- Ensure that appropriate processes are in place for identifying, analyzing and dealing with risks, and that these work effectively;
- Communicate with stakeholders to ensure that everyone is aware Of their responsibilities for risk management;
- Know how the organization will manage a crisis;
- Assess the performance of risk management.

On the one hand, succeeding in all of these aspects is difficult. A study by Macdonald and Corsi (2013) suggests that this is partly due to low resource availability, which has a major influence on the willingness to prepare and can be expected to be even more accentuated in developing countries. It also suggests that even though supply chain management is currently cost-driven, the financial impact of disruptions is hard to quantify. Company leaders should not be discouraged though, as on the other hand well-defined policies for supply chain risk management and its proper implementation tend to reduce costs, improve performance and have various other benefits (Waters 2011).

Buy-in and continuous support from company leadership are important to set up and maintain an effective risk management strategy. However, many risks originate from and have to be handled on the shop floor. It is thus wise to involve people lower down the organization, who identify risks in their normal work and suggest ways of dealing with them; both approaches are needed in practice to give a comprehensive view of risks (Waters 2011). Current port preparedness initiatives apply this insight by ensuring top-level management commitment first, before engaging lower and medium management in workshops.

Difficulties with Risk Identification, Analysis and Evaluation

How does one proceed after defining a good risk management strategy? Common approaches[5] usually involve the definition of concrete risks that would have a severe impact on operations when they manifest, i.e. risk identification and analysis. However, "severity" is difficult to define, and thus supply chain risk management

[5] Waters (2011) presents several techniques to identify risks, e.g. a general five-step procedure that systematically breaks down the supply chain into series of operations and analyses each of them, process charts, the analysis of past events with tools like cause-and-effect diagrams or Pareto charts, or the Delphi method.

frameworks and constructs that exist to date merely presume that the disruption is severe (MacDonald and Corsi 2013). The assessment of event probability is difficult too and has been relatively little researched; in practice, probabilities are often little more than subjective guesses (Meixell and Norbis 2011, Zsidisin et al. 2004, Waters 2011).

How should one avoid the estimation of risk or prepare for risks that cannot be defined at all, because the disruption only becomes known when it occurs? An effective yet extreme way to handle these problems is to disregard probability completely, preparing instead for the complete failure of individual critical elements. This is the basic approach of business continuity management (BCM). According to Waters (2011), business continuity management is a process developed to counteract systems failure by anticipating incidents which will affect mission critical functions and processes for the organization and ensuring that it responds to any incident in a planned and rehearsed manner. It thus develops ways of responding to unidentified or unidentifiable risks. Waters continues to state, however, that most BCM plans do not cover damage to the corporate image, supply chain disruption and severe weather – all of which managers are commonly concerned with (Scarborough 2007). Still we may agree to Husdal (2009a), who contends that in our case[6], supply chain risk managers should draw on business continuity management for advice. Another simple approach to determine the criticality of elements was developed in conjunction with the military, as described in the following.

The Mission Dependency Index

In 2007, Antelman et al. (2007) published the results from the development and deployment of a risk-based metric that links facilities to mission: the Mission Dependency Index (MDI). The MDI is highly relevant for port preparedness, as it

- Deals directly with the criticality of objects that have a mission-related function and occupy a dedicated space, e.g. port infrastructure such as runways, piers or storage facilities;
- May improve ports' operational and financial management;
- May be combined with other metrics (Uzarski 2004), such as the Condition Index (CI) to prioritize funding for projects;
- Has been successfully deployed by the US Naval Facilities Engineering Command (NAVFAC), United States Coast Guard (USCG) Office of Civil Engi-

[6] To be precise, Husdal (2009a) speaks of sparse transportation network settings. In the case of ports this situation is given though, as constraints apply to both transportation mode and transportation link choice.

neering, and the US National Aeronautical and Space Administration (NASA), who are all well versed in managing risks.

The MDI's practicality is underlined by the US General Services Administration naming it a best practice and the US Federal Facilities Council calling it "a promising process indicator for prioritizing projects and funding to support an organization's overall mission". How does it work?

To calculate the MDI, first a list of critical objects (*functional elements*, e.g. a warehouse) is established. Next, the objects' representatives (e.g. warehouse managers) are asked a series of intra-dependency questions (1 and 2) and inter-dependency questions (3 and 4) about the objects.

1. **How long could the "functions" supported by your facility (*functional element*) be stopped without adverse impact to the mission?**
   Possible answers are: **immediate**; **brief**, i.e. less than 24 hours; **short**, i.e. less than 7 days; **prolonged**.
2. **If your facility was no longer functional could you continue performing your mission by using another facility, or by setting up temporary facilities?** (Are there workarounds?)
   Possible answers are: **impossible**, i.e. an alternate location is not available; **extremely difficult**, i.e. using an available location with minimally acceptable capabilities would require either a significant effort, dislocation of another major occupant, or contracting for additional services and/or facilities to complete; **difficult**, i.e. using an alternate location with acceptable capabilities and capacity would require a measurable level of effort; **possible**, i.e. using an alternate location with sufficient capabilities and capacity has been budgeted or can easily be absorbed.
3. **How long could the services provided by *functional element* be interrupted before impacting your mission readiness?**
   Possible answers are basically the same as for question 1.
4. **How difficult would it be to replace or replicate the services provided by *functional element* with another provider from any source before impacting the command's mission readiness?**
   Possible answers are basically the same as for question 2.

The coded answers are then used in conjunction with risk assessment matrices to determine intra-dependency scores and inter-dependency scores. The resulting scores are then used as variables in a linear equation with weighted coefficients to calculate the MDI for each functional element[7]. Eventually, the average MDI is calculated. MDI scores may range from 0 to 100 and associated to five categories (low, moderate, relevant, significant, critical), which are also color-coded. The

[7] The matrices and weighted coefficients have been determined empirically during extensive field-testing by Navy, Coast Guard and NASA facility engineers and managers. They may be directly applicable to the ports we are interested in or require tweaking, which could be examined by field-testing.

color-coding is useful to create maps that give a visual overview of critical elements in the area under examination.

Ideas for New Initiatives

The following two concepts – the Airport Certification Program and the idea of a logistic white fleet – may very well complement the existing initiatives to further push the frontline of addressing port resiliency issues.

Airport Certification Program (ACP)

One way to solve the problems of motivation and funding of efforts to improve the risk management, robustness, flexibility/agility, and resiliency of airports would be to create a formal program to certify that an airport has achieved a clearly defined level of preparedness. This in itself would not achieve the goals of motivation and funding; however, doing it completely and verifiably invites recognition by the insurance and reinsurance industry. The resulting financial benefits to the ports or their primary users will tend to engender both motivation and a willingness to invest in preparedness.

Such an airport certification program (ACP) should involve the constellation of interrelated activities to promote and document the actions taken and their effectiveness. These actions might include:

- Global standards tied to specific activity types with adjustments to specific risk types and levels
- Technical assistance to build on ports' existing facilities, plans, programs, and procedures to reach greater resiliency at the lowest possible cost
- Certification--the Port Resiliency Certification--at several clearly defined levels of resiliency that reflect levels of effort and accomplishment by a port seeking to improve and document its resiliency
- On-site verification of level of resiliency by qualified inspectors and evaluators
- Periodic re-certification
- Certification of providers to assist a port develop resiliency programs to qualify for certification or re-certification
- Data collection and analysis to document effectiveness of port resiliency certification
- Development of measures of effectiveness (metrics)
- Registry of certified ports
- Registry of certified providers
- Sponsorship of research into effectiveness of methods to enhance resiliency and new methods

The greatest challenges in developing such a certification program are the developing standards on which to base the certification process and gaining the recognition of the insurance and reinsurance industry that the certification has sufficient meaning to justify the insurance benefits. It will also be a challenge to fund the development of the certification program.

A possible model for an airport certification program for preparedness can be found in the Green Building Council's Leadership in Energy and Environmental Design (LEED) program of standards and certification (USGBC 2014).

Logistic White Fleet

One outside-the-box concept for seaport resiliency would bypass the problem of inadequate, damaged, or destroyed ports completely. Inspired by the white hospital ships that have responded effectively to disasters around the world, Rabjohn (2013) has proposed to form a "logistic white fleet" of retired naval amphibious-capable ships such as landing ship tanks (LSTs) and smaller landing craft which have a greater range of applications and are independent of port facilities. The logistic white fleet is deployed at safe ports in regions of the world where isolated areas are at a high risk of disasters. Examples of such areas are the Caribbean Sea for hurricanes and earthquakes, Southeast Asia-Oceania for typhoons, earthquakes, and volcanoes, and the Persian Gulf or Red Sea for earthquakes. The white fleet is manned by retired sailors from the merchant marine and navies led by volunteers from the major maritime companies. Ships of the logistic white fleet serve as containers for pre-positioned relief supplies and are able to deliver those supplies and additional materials to any coastline regardless of the availability of a seaport. .

Conclusion

Numerous disasters have shown how airports and seaports with inadequate resiliency have been unable to handle the surge of activity inherent in disaster response and recovery or even to maintain any activities at all. The existing initiatives have demonstrated that preparing ports can help.

GARD and PReP have been applied to real airports in areas known to have high risks of disaster. The three existing initiatives are not static but actively evolve and expand their capabilities. DHL was deeply involved in the management and coordination of relief activities using Cebu International Airport in the Philippines after the 2013 typhoon and has scheduled its next GARD workshop for that airport in March 2014. GARD plans a minimum of three workshops—that is, their basic package of services to an airport or group of neighboring airports—a year. The new follow-up format "GARD plus" suggests a lively interest and in-

creased awareness at ports that have participated in GARD. An important next step for GSRD is to demonstrate its applicability and usefulness with a pilot project at an African seaport during 2014. PReP is revising its financial model to allow it to serve more airports, planning to do two airports in summer and fall 2014. Eventually, PReP plans to do four to eight airports a quarter and two seaports a year, but this is dependent on developing a sound financial model and effective ways to motivate ports to seek the service.

The collaborative spirit among the initiatives is remarkable, allowing to make use of the major opportunity for cross-fertilization and collaboration. Such cross-fertilization and collaboration is necessary to find solutions for three critical areas:

- Means of motivating ports to enhance their resiliency
- Relationship to insurance
- Funding mechanisms

The tools of supply chain risk management including the MDI are directly pertinent to efforts to make ports better prepared to handle the demands of humanitarian aid for relief and recovery following natural and manmade disasters. The tools have several benefits. Firstly, they enable us to better understand the similarities between the initiatives' methodologies. Furthermore, they offer valuable insights for the managers of similar initiatives, which may lead to programmatic improvements. They may also inspire port authorities, aid organizations, governments and other port stakeholders to engage more actively in port resiliency program development or make a financial investment. Lastly, they inspire readers to take a supply chain risk management perspective when addressing other processes, such as warehouse management or last mile delivery.

Learning from supply chain risk management may lead to further improvement of the three existing initiatives that substantially incorporate such tools already. It may also lead to the critical evaluation of ideas at the forefront of port preparedness, such as the Airport Certification Program or the idea of establishing a logistic white fleet. Similarities among the existing programs strongly suggest traits that should characterize a globally applicable port risk management and resiliency program.We are grateful towards Ms. Anna Birk (Manager of Corporate Citizenship, Deutsche Post DHL) and Mr. Gilbert Castro (DHL Response Team Manager for International Americas) for providing details about GARD for Table 3. Furthermore, we want to thank Prof. Dr. Kim Kenville (Department of Aeronautics, University of North Dakota) and Mr. John M. Sawyer (JMS Airfield Safety Consultants) for their invaluable advice.

References

Antelmann, A., Dempsey, J. J., and Brodt, B. (2007) Mission Dependency Index – A Metric for Determining Infrastructure Criticality. In: Amekudzi, A., and McNeil, S. (eds.), Infrastructure Reporting and Asset Management. American Society of Civil Engineers, Reston, VA.

Babun, T. A. and Smith, J. F. (2013). The Port Resiliency Program (PReP): Upgrading logistics at Latin American and Caribbean Ports. In Hellingrath, B., Link, D., & Widera, A. (eds.),

Managing humanitarian supply chains: Strategies, practices and research, pp. 176-187. DVV Media Group, Hamburg, Germany.

Berle, Ø., Rice, J. B., Asbjørnsletta, B. E. (2011) Failure modes in the maritime transportation system: a functional approach to throughput vulnerability. In: Maritime Policy & Management, Vol. 38, Nr. 6, p. 605-632.

Bhamra, R., Dani, S., and Burnard, K. (2011) Resilience: The Concept, a Literature Review, and Future Directions. International Journal of Production Research 49(18):5375–93.

Blecken, A. (2010) Humanitarian Logistics: Modelling Supply Chain Processes of Humanitarian Organizations. Haupt Verlag, Bern.

Bloetscher, F., Berry, L., Rodriguez-Seda, J., Hammer, N., Romah, T., Jolovic, D., Heimlich, B., and Cahill, M. (2013) Identifying FDOT's Physical Transportation Infrastructure Vulnerable to Sea Level Rise. In: Journal of Infrastructure Systems.

Bogataj, D., and Bogataj, M. (2007) Measuring the supply chain risk and vulnerability in frequency space. International Journal of Production Economics 108(1–2): 291–301.

Boucher, M., and Guimond, A. (2012) Assessing the Vulnerability of Ministère des Transports du Québec Infrastructure in Nunavik in a Context of Thawing Permafrost and the Development of an Adaptation Strategy. In: Cold Regions Engineering, p. 504-5014.

DPDHL [Deutsche Post DHL] (2014). Disaster relief needs efficiency: The GARD program from DHL and UNDP. http://www.dpdhl.com/content/dam/nachhaltigkeit/gohelp/gard_brochure.pdf (last checked: 19th January 2014).

Hofmann, H., Busse, C., Bode, C. and Henke, M. (2013) Sustainability-Related Supply Chain Risks: Conceptualization and Management. In: Welford, R. (ed.), Business Strategy and the Environment.

Husdal, J. (2009a) Supply Chain Disruptions in Sparse Transportation Networks: Does Location Matter? In: Proceedings of the 93rd Annual Meeting of the Transportation Research Board.

Husdal, J. (2009b) De-confusing SCRM: robustness, resilience, flexibility and agility. Available online at: http://www.husdal.com/2009/05/26/robustness-resilience-flexibility-agility/ (last checked: 19th January 2014).

ISO [International Organization for Standardization] (2009): ISO 31000:2009 Risk management – Principles and guidelines. International Organization for Standardization: Geneva, Switzerland.

Jereb, B., Cvahte, T., and Rosi, B. (2011) Risk Assessment Model and Supply Chain Risk Catalog. Business Logistics in Modern Management, Vol. 11, pp. 35-46.

Levy, M.J., and Bissell, Rick (2013) Overview of Critical Infrastructure in Catastrophes. In: Bissell, R. (ed.), Preparedness and Response for Catastrophic Disasters.

MacDonald, J. R., and Corsi, T. M. (2013) Supply Chain Disruption Management: Severe Events, Recovery, and Performance. Journal of Business Logistics, 34(4), pp. 270-288.

McLaughlin, B. J., Murrell, S. D., DesRoches, S. (2011) Case Study: Assessment of the Vulnerability of Port Authority of NY & NJ Facilities to the Impacts of Climate Change. In: *Transportation and Development Institute Congress 2011 : Integrated Transportation and Development for a Better Tomorrow*.

Meier, S. (2011) Logistik sichert effective Hilfe im Katastrophenfall. In: Baumgarten, H., Schwarz, J., & Keßler, M. (eds.), Humanitäre Logistik: Herausforderungen und Potenziale der Logistik in der humanitären Hilfe, pp. 57-68. DVV Media Group, Hamburg, Germany.

Meixell, M. J., and Norbis, M. (2011) Assessing Security Risks in Global Supply Chains. In: Proceedings of the 2011 IEEE Int'l Technology Management Conference.

Minahan, T. A. (2005) The Supply Risk Benchmark Report. Aberdeen Group, Boston, MA.

Möhring, F., and Link, D. (2013). Get Seaports Ready for Disaster – Strengthening preparedness at African seaports by improving performance. . In Hellingrath, B., Link, D., & Widera, A. (eds.), Managing humanitarian supply chains: Strategies, practices and research. DVV Media Group, Hamburg, Germany.

Rabjohn, A. (2013). A proposal for a logistic white fleet for disaster relief. In Smith, J., Port Resiliency [blog]. http://www.caribbeanmaritimeexchange.org/portresiliency.html

Rao, S., and Goldsby, T. J. (2009) Supply chain risks: A review and typology. International Journal of Logistics Management 20(1): 97–123.

Scarborough, J. (2007) Risks during Transportation. RPW Reports, London.

Smith, J., Möhring, F. and Link, D. (2013). Making ports more resilient. Monthly Developments, November 2013.

Sodhi, M. S., Son, B.-G., and Tang, C. S. (2012) Researchers' perspectives on supply chain risk management. Production and Operations Management 21(1): 1–13.

UN [United Nations] (2014). Get Airports Ready for Disaster—An initiative of Deutsche Post DHL and UNDP. http://business.un.org/en/documents/5482 (last checked: 19th January 2014).

USAID [United States Agency for International Development] (2013) Case Study, Supply Chain Risk Management: USAID | DELIVER PROJECT, Task Order 5. Available online at: http://deliver.jsi.com/dlvr_content/resources/allpubs/logisticsbriefs/SuppChaiRiskMgmt_TO5.pdf (last checked: 19th January 2014).

USGBC [United States Green Building Council] (2014). LEED – Leadership in Energy & Environmental Design. http://www.usgbc.org/leed (last checked: 19th January 2014).

Uzarski, D. (2004) Builder Knowledge-Based Inventory Manual for Buildings, U.S. Army Engineer Research and Development Center, Construction engineering Research Laboratory, Champaign, IL.

Vanany, I., Zailani, S., and Pujawan, N. (2009) Supply Chain Risk Management: Literature Review and Future Research. In: 16 Int'l Journal of Information Systems and Supply Chain Management, Vol. 2, Nr. 1, p. 16-33.

Waters, C. D. J. (2011) Supply chain risk management : vulnerability and resilience in logistics. Kogan Page Limited.

Zsidisin, G. A., Ellram, L. M., Carter, J. R., and Cavinato, J. L. (2004) An analysis of supply risk assessment techniques, International Journal of Physical Distribution & Logistics Management, vol. 34, pp. 397-413.