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Enhancing Navy HADR Readiness Through Scenario-Based Logistics Optimization in the Indo-Pacific

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Enhancing Navy HADR Readiness Through Scenario-Based Logistics Optimization in the Indo-Pacific

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Abstract

The Indo-Pacific region faces increasing vulnerability to natural disasters, requiring rapid and sustained humanitarian assistance and disaster relief (HADR) operations. The U.S. Navy often plays a central role in these operations, leveraging its global reach, logistical capabilities, and forward-deployed assets to respond quickly and effectively to disasters across the region. However, current logistics planning lacks a standardized framework to determine when to deploy prepositioned supplies, rely on CONUS-based assets, or use a hybrid approach. This decision is highly dependent on the disaster's location, severity, and impact on local infrastructure.

HADR operations are central to U.S. theater strategy in the Indo-Pacific: they project American influence, strengthen relationships with allied and partner nations, and reinforce regional presence in ways that serve both humanitarian and long-term strategic objectives. Improving logistics readiness for these missions therefore supports distributed sustainment, increases asset availability, and contributes to a more resilient and strategically positioned force. Ultimately, this framework aims to inform acquisition, pre-positioning, and logistics planning for future naval operations, ensuring that humanitarian response capabilities also contribute to long-term force readiness and strategic advantage.

This research proposes a scenario-based modeling approach using the Opus Suite (specifically OPUS10 and SIMLOX) to evaluate logistics strategies across diverse HADR scenarios. Historical operations such as Operation Tomodachi (Japan, 2011) and the response to Typhoon Haiyan (Philippines, 2013) serve as foundational case studies, illustrating the diversity of logistical challenges and the need for adaptable strategies.

A single OPUS10 model was developed to generate an ideal stocking solution across the Indo-Pacific supply chain network. This optimized configuration then served as the baseline input for SIMLOX simulations, which assessed mission success over time by first removing stock from specific locations, simulating those locations being struck by a disaster, and then comparing how mission success recovered when resupply was provided from one location versus another versus multiple locations simultaneously.

This comparative analysis across resupply configurations identifies not only which stocking locations are most critical to mission success when lost, but which alternate sources are most effective at restoring it. More broadly, this methodology can be applied to optimize emergency relief supply locations across the Indo-PACOM theater, identifying the most effective pre-positioning network to address the full range of disaster scenarios in the region. The results provide actionable, scenario-specific decision support for logistics planners determining where to route resupply assets when a forward location is compromised by a disaster.

Keywords: Humanitarian Assistance and Disaster Relief, Prepositioned and CONUS-Based Supplies, Life Cycle Logistics Management, Last-Mile Logistics, Solution-focused Modeling

Introduction

The Indo-Pacific is among the most disaster-prone regions in the world. Located along the Pacific Ring of Fire, the region is subject to frequent seismic activity, tsunamis, and volcanic events, while seasonal typhoon cycles bring destructive storms to densely populated coastal nations each year. These hazards demand rapid and sustained humanitarian response. The United States Navy is uniquely positioned to lead such responses due to its forward-deployed assets, hospital ships, and expeditionary logistics capabilities. However, the effectiveness of any HADR operation ultimately depends not on the platforms themselves, but on whether the right supplies reach the right people via the right system in the most effective and time-efficient means possible.

Despite this recognized need, current U.S. Indo-Pacific Command (USINDOPACOM) logistics planning for HADR lacks a standardized, scenario-driven framework for determining the optimal sourcing strategy; whether to draw from prepositioned stocks in theater, rely on CONUS-based assets, or pursue a hybrid combination. This gap introduces risk: in HADR operations time is of the essence, and delayed supplies mean delayed medical care, shelter, and sustenance for disaster survivors. Supplies arriving too slowly due to long CONUS transit times, or prepositioned stocks that are misallocated or insufficiently sized, can mean the difference between life and death in the critical first hours of a response.

This research addresses that gap by adapting commercially available logistics optimization and simulation (COTS) software, specifically the Opus Suite, to model HADR-specific supply chains across the Indo-Pacific. The Opus Suite is designed for logistics management, maximizing and optimizing system effectiveness across complex supply networks, and is used across defense, aerospace, energy, and transportation industries. OPUS10 generates an optimized baseline stocking solution; SIMLOX simulates mission success under degraded network conditions. This paper applies the software in a novel way; these tools are designed for life cycle logistics management and system readiness optimization, not humanitarian logistics, demonstrating how creative analytical adaptation can extend existing tools to novel operational challenges.

Background and Motivation

The HADR Challenge in the Indo-Pacific

The Indo-Pacific encompasses some of the world’s most seismically and meteorologically active zones. Asia alone accounts for nearly one-third of all weather, climate, and water-related disasters reported globally, and nearly half of all associated deaths (World Meteorological Organization [WMO], 2022). Between 1970 and 2019, the region recorded 3,454 disasters, with 975,622 lives lost and more than $1.2 trillion in economic damages (WMO, 2022).

Two historical operations frame this research. Operation Tomodachi (2011) followed the Tohoku earthquake and tsunami in Japan. At its peak, the U.S. military deployed approximately 24,000 personnel, 189 aircraft, and 24 naval vessels; the single largest humanitarian relief effort in American history at the time (Center for Strategic and International Studies [CSIS], 2011). The response to Typhoon Haiyan (Philippines, 2013) illustrated a different challenge: infrastructure almost entirely destroyed, port facilities at Tacloban severely damaged, and last-mile distribution hindered by road damage and fuel shortages (Congressional Research Service [CRS], 2014). Notably, the USNS Mercy was activated and readied for deployment but was ultimately not sent. Its San Diego homeport meant a multi-week transit compared to days for forward-deployed assets already in theater. These cases collectively motivate the central research question: how can the Department of War (DoW) systematically determine the optimal logistics strategy before a disaster occurs?

The Pre-positioning Decision

Logistics planners face a fundamental tradeoff when preparing for HADR operations. Pre-positioning supplies forward at locations such as Guam, Pearl Harbor, Subic Bay, or Japan reduces response time dramatically but requires sustained investment in inventory management, storage infrastructure, and periodic resupply. CONUS-based logistics are more cost-effective in peacetime but introduce 5 to 14 days of transit time before adequate bulk supplies reach an Indo-Pacific disaster zone, meaning that while some initial supplies may arrive quickly, the full volume of materiel needed for sustained operations could take days to weeks to deliver.

A hybrid approach attempts to balance both, using pre-positioned stocks to enable immediate response while CONUS shipments build sustained capacity. The challenge is that this decision has historically been made through heuristic judgment rather than quantitative optimization. This research proposes to change that through scenario-based modeling.

The Opus Suite: Opus10 and Simlox

Overview

The Opus Suite is a commercially developed logistics analysis and simulation toolset used by organizations across defense, aerospace, energy, transportation, and other asset-intensive industries for life cycle logistics management and spare parts optimization (Defense Acquisition University [DAU], n.d.; Systecon AB, n.d.-a). This research uses two components: OPUS10 for optimization and SIMLOX for simulation.

OPUS10: Organic Use and HADR Adaptation

In its organic application, OPUS10 models parts and components for a technical system and determines how to stock them across a maintenance supply chain hierarchy. The primary output is a Cost/Efficiency (C/E) curve, a graph plotting system availability against investment cost. Each point on the curve represents a distinct stocking solution achieving maximum availability for a given budget. The analyst selects the point representing the best operational and cost tradeoff; OPUS10 outputs the recommended stock quantities at each supply chain location. Traditionally, the supply chain is hierarchical (OEM → regional depots → operational bases), with replenishment flowing from higher to lower echelons as parts are consumed. OPUS10 can reduce spare parts investment by 30% or more compared to conventional methods (Systecon AB, n.d.-b).

In this research, HADR supplies such water, MREs, hygiene kits, cots, IFAKs, SSS, LWPS, and medical items are treated as "consumable parts" with population-based failure rates set to 100% on deployment. This means each item is modeled as fully consumed when used; a case of water, for example, cannot be regenerated once distributed, so for the "system" to maintain availability it must be replenished before it can be used again. This framing allows OPUS10 to optimize stock quantities and placement as it would for any consumable component in a traditional logistics model. Rather than a strict hierarchy, the supply network is an integrated web: California (highest echelon) flows rightward to Pearl Harbor, Guam, Subic Bay, Cebu, and Japan, with lateral connections between forward locations allowing stock to flow between theater locations.

IMLOX: Organic Use and HADR Workarounds

In organic use, SIMLOX takes the OPUS10 stocking solution and simulates how availability and mission success evolve over time under real operational dynamics, using Monte Carlo discrete-event simulation (Systecon AB, n.d.-c). SIMLOX reveals whether the selected C/E curve point holds up under the variability of actual operations.

Applying SIMLOX to HADR required two deliberate workarounds. First, SIMLOX cannot simulate platforms traveling between locations to deliver supplies; it models fixed-node availability, not mobile resupply. To work around this, a disaster location is omitted from the model entirely, treating that location's absence as a proxy for lost supply availability. Second, to simulate resupply from alternate sources, the systems originally assigned to the omitted node are reallocated to one or more other locations. This increases demand at those locations, causing their stock to be consumed in place of the lost location's contribution. Comparing mission success across these reallocation configurations identifies which resupply arrangements are most effective.

A Novel Application

This research represents a novel, nontraditional application of the Opus Suite, extending a life cycle logistics management and system readiness toolset into the humanitarian assistance domain. Rather than pushing the boundaries of intended use, this application demonstrates the inherent flexibility of the Opus Suite's analytical framework. By mapping humanitarian supply chains onto its models, treating pallets of water and MREs as "items," delivery platforms as "systems," and disaster population needs as "operational demand," the research adapts well-established logistics optimization methods to a new and operationally significant context. The supply chain architecture is modeled as an integrated network rather than a clean hierarchy, and the SIMLOX workarounds described in the SIMLOX: Organic Use and HADR Workarounds Section enable meaningful scenario analysis within the simulation framework.

This novel application demonstrates both the flexibility of the Opus Suite as an analytical platform and the broader principle that rigorous logistics optimization methods, originally designed for one context, can yield actionable insights when thoughtfully adapted to new domains.

Methodology

Supply Items and Failure Rates

Eight supply categories were modeled: Water (pallets or cases), MREs (pallets or cases), Hygiene Kits, SSS, Cots, IFAKs, LWPS, and hospital/medical items (berths, operating rooms, oxygen/water plants, medical consumables). Each was assigned a Failure Rate (FR) derived from population-normalized demand. For example, 20 pallets of water sustain 1,000 people for 7 days; 10 MRE pallets sustain 1,000 people for 3 days. FRs were computed as: pallets required ÷ (population × duration in hours) × 1,000,000, expressed as pallets per million operational hours.

Platforms and Supply Chain

Four platform types were modeled, each with defined maximum cargo capacities: USNS Mercy (T-AH 19), T-AKE cargo ships, MV-22 Osprey, and C-130 Hercules. It is worth noting that additional platforms can be added or removed from the model as needed; the four selected here represent a representative set for this research proof of concept, chosen to capture the range of sealift and airlift capabilities most relevant to Indo-Pacific HADR operations. The supply chain network spans California (DLA) as the CONUS source, with forward locations at Pearl Harbor, Subic Bay, Cebu, Guam, and Mainland Japan. Supply flows: California → all five forward locations; Pearl Harbor → Guam; Subic Bay and Cebu → Japan; Guam → Japan.

SIMLOX Scenario Design

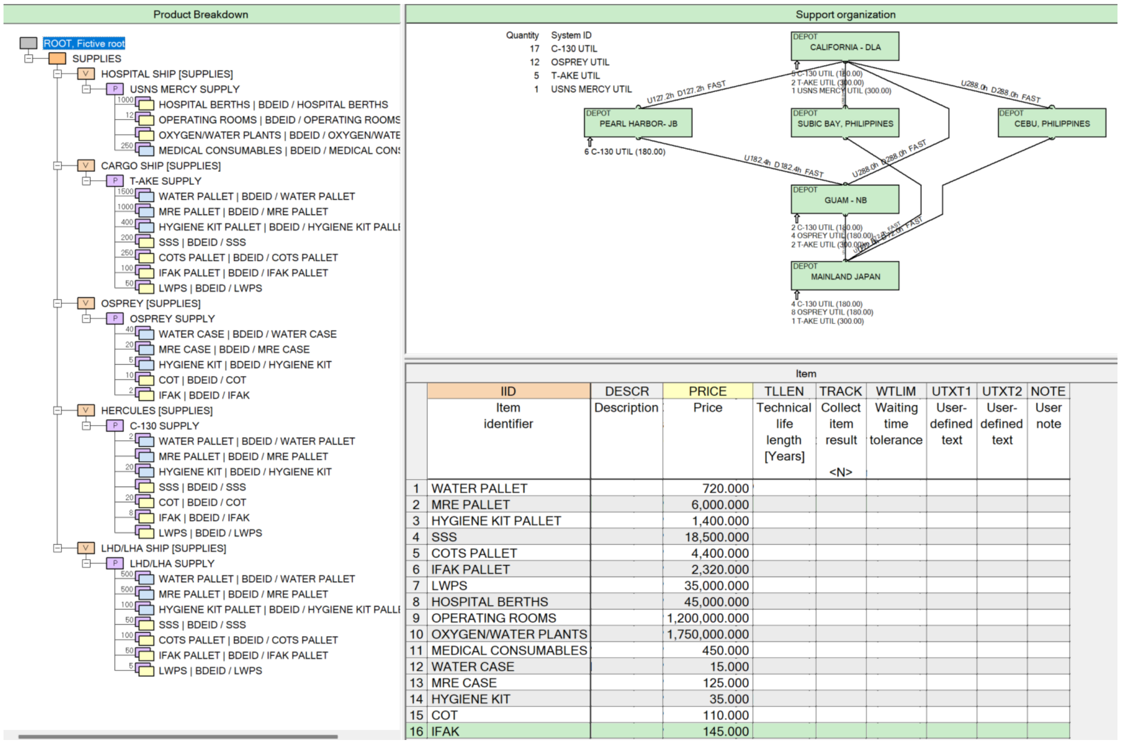
The operational scenario assumes ships conducting missions once or twice per week and aircraft conducting missions approximately five times per week over one month, reflecting sustained HADR tempo. Three degraded-network scenarios were analyzed: loss of Japan, loss of Guam, and loss of Pearl Harbor, each tested under multiple resupply configurations: relocating systems to a single alternate location (varied by which node), and dispersing systems across multiple locations simultaneously.

Results and Analysis

This section presents the results of the OPUS10 optimization and SIMLOX simulation analyses. Results are organized sequentially: first, the OPUS10 model structure and the stocking solution derived from the selected point on the Cost/Efficiency curve; second, the SIMLOX baseline mission performance with the full network active; and third, the degraded-network scenarios examining mission success when individual stocking locations are removed and systems are reallocated to alternative sources.

OPUS10 Model and Stocking Solution

Figure 1 shows the OPUS10 model. The left panel displays the product breakdown structure with all four platforms and their associated supply items. The upper-right panel shows the supply chain network, with California-DLA at the top, flowing to Pearl Harbor, Subic Bay, Cebu, Guam, and Japan, with transit times and modes annotated. The lower-right panel lists all 16 supply items with their assigned unit costs.



Quantity	System ID
17	C-130 UTIL
12	OSPREY UTIL
5	T-AKE UTIL
1	USNS MERCY UTIL

Item

	IID Item identifier	DESCR Description	PRICE Price	TLLEN Technical life length [Years]	TRACK Collect item result <N>	WTLIM Waiting time tolerance	UTXT1 User-defined text	UTXT2 User-defined text	NOTE User note
1	WATER PALLET		720.000						
2	MRE PALLET		6,000.000						
3	HYGIENE KIT PALLET		1,400.000						
4	SSS		18,500.000						
5	COTS PALLET		4,400.000						
6	IFAK PALLET		2,320.000						
7	LWPS		35,000.000						
8	HOSPITAL BERTHS		45,000.000						
9	OPERATING ROOMS		1,200,000.000						
10	OXYGEN/WATER PLANTS		1,750,000.000						
11	MEDICAL CONSUMABLES		450.000						
12	WATER CASE		15.000						
13	MRE CASE		125.000						
14	HYGIENE KIT		35.000						
15	COT		110.000						
16	IFAK		145.000						

Figure 1. OPUS10 Model: Product Breakdown (Left), Supply Chain Network (Upper Right), Item Costs (Lower Right)

Figure 2 presents the C/E curve generated by OPUS10 for the HADR scenario. The horizontal axis represents life support cost, representing the total investment in pre-positioned stock across all locations, while the vertical axis represents system availability, translated in this context to the proportion of supply demand that can be met across the network. Each point on the curve represents a distinct stocking solution: the allocation of item quantities across stations that achieves the highest possible availability for a given investment level. The curve exhibits the classic diminishing returns shape characteristic of OPUS10 outputs: early investment produces large availability gains, while spending beyond the curve's inflection point yields progressively smaller improvements.

The selected solution point, highlighted as the filled circle on the curve, corresponds to a life support cost of approximately $1.2 million and represents the first point on the curve at which system availability reaches approximately 99%. In the context of HADR planning, this selection logic is deliberate: when disaster response is the mission, achieving the highest possible supply availability at the lowest justifiable cost is the optimal posture. Selecting a point further right on the curve would yield marginal further gains at disproportionate additional investment; selecting a point to the left would meaningfully reduce supply assurance during a time-critical humanitarian operation.

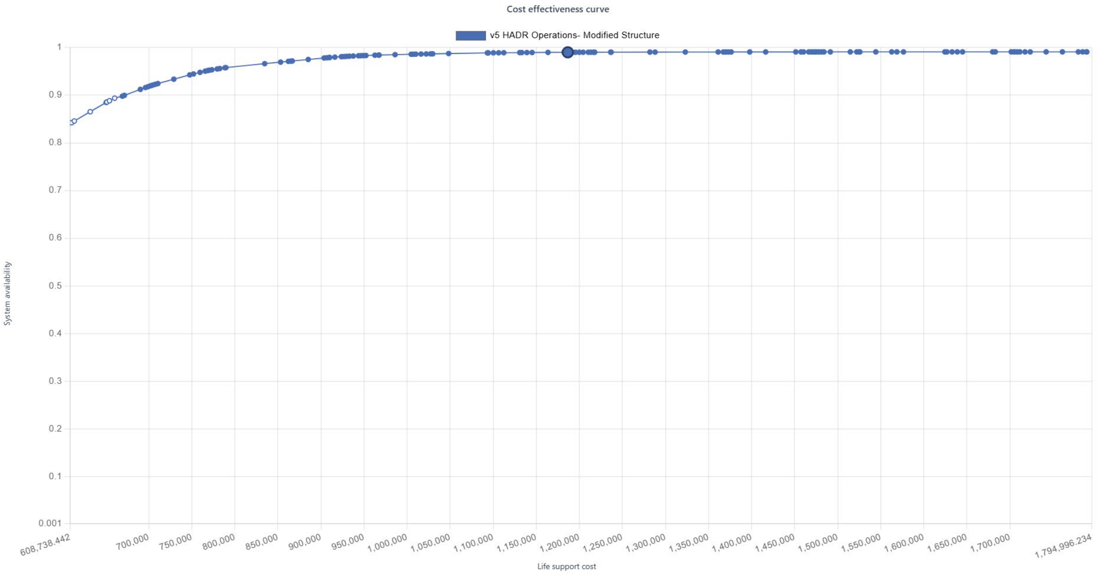
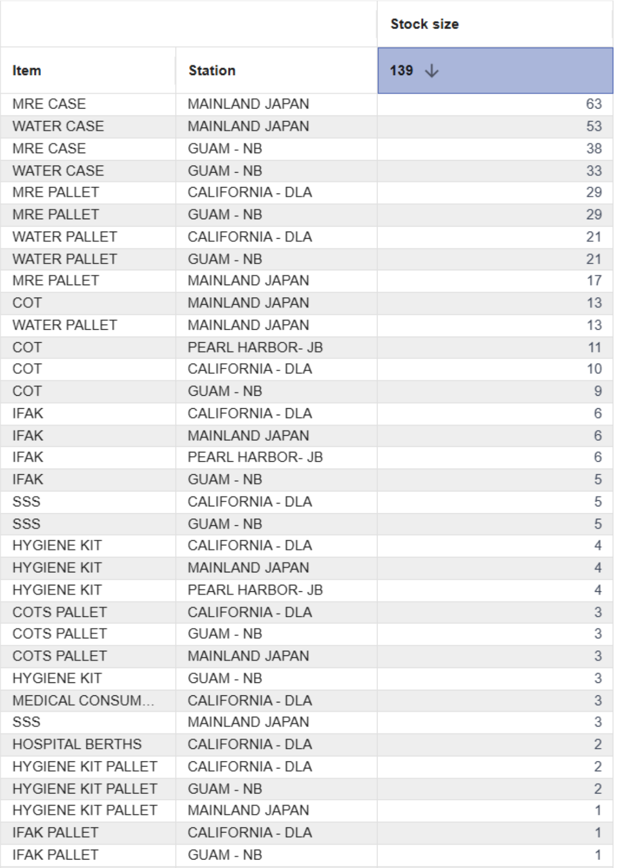


Figure 2. OPUS10 Cost/Efficiency Curve. Selected Operating Point (Filled Circle): ~$1.2 Million, First Point Reaching ~99% Availability.

Figure 3 presents a portion of the stocking solution output by OPUS10 at the selected operating point, sorted by stock quantity in descending order. The solution concentrates the highest quantities at Mainland Japan and Guam, the two forward locations farthest from CONUS and most likely to serve as primary distribution hubs for Northeast Asian and Western Pacific scenarios. MRE Cases (63 units) and Water Cases (53 units) represent the largest single- location allocations, both at Japan, reflecting their high failure rates and immediate life-sustaining priority. California carries meaningful quantities of palletized items (MRE Pallets: 29, Water Pallets: 21, and Cots: 10), representing the CONUS reserve for surge operations. The broad distribution of IFAKs, Hygiene Kits, SSS, and Cots Pallets across multiple stations reflects the model’s recognition that these items are needed at any disaster location regardless of geography and should be distributed widely rather than concentrated at a single hub.



		Stock size
Item	Station	139 ↓
MRE CASE	MAINLAND JAPAN	63
WATER CASE	MAINLAND JAPAN	53
MRE CASE	GUAM - NB	38
WATER CASE	GUAM - NB	33
MRE PALLET	CALIFORNIA - DLA	29
MRE PALLET	GUAM - NB	29
WATER PALLET	CALIFORNIA - DLA	21
WATER PALLET	GUAM - NB	21
MRE PALLET	MAINLAND JAPAN	17
COT	MAINLAND JAPAN	13
WATER PALLET	MAINLAND JAPAN	13
COT	PEARL HARBOR- JB	11
COT	CALIFORNIA - DLA	10
COT	GUAM - NB	9
IFAK	CALIFORNIA - DLA	6
IFAK	MAINLAND JAPAN	6
IFAK	PEARL HARBOR- JB	6
IFAK	GUAM - NB	5
SSS	CALIFORNIA - DLA	5
SSS	GUAM - NB	5
HYGIENE KIT	CALIFORNIA - DLA	4
HYGIENE KIT	MAINLAND JAPAN	4
HYGIENE KIT	PEARL HARBOR- JB	4
COTS PALLET	CALIFORNIA - DLA	3
COTS PALLET	GUAM - NB	3
COTS PALLET	MAINLAND JAPAN	3
HYGIENE KIT	GUAM - NB	3
MEDICAL CONSUM...	CALIFORNIA - DLA	3
SSS	MAINLAND JAPAN	3
HOSPITAL BERTHS	CALIFORNIA - DLA	2
HYGIENE KIT PALLET	CALIFORNIA - DLA	2
HYGIENE KIT PALLET	GUAM - NB	2
HYGIENE KIT PALLET	MAINLAND JAPAN	1
IFAK PALLET	CALIFORNIA - DLA	1
IFAK PALLET	GUAM - NB	1

Figure 3. OPUS10 Stocking Solution at the Selected Operating Point (Top Entries, Sorted by Quantity)

SIMLOX Baseline Performance

With the OPUS10 stocking solution established as the baseline configuration, the initial SIMLOX simulation assessed mission success under nominal network conditions, with all stocking locations active and no disruptions. The operational scenario assumed ships conducting missions once or twice per week and aircraft conducting missions approximately five times per week over one month, reflecting a realistic sustained HADR tempo.

Figure 4 presents the baseline result. With the full network active, the simulation yields a mission success rate of 65.55%, with 34.45% of mission time experiencing supply shortfalls. An important caveat applies to this figure: because this is a novel application of SIMLOX, supply shortfalls manifest in the simulation as parts “failing” on the modeled systems (the standard SIMLOX mechanism for tracking unavailability), rather than through a purpose-built HADR demand model. As a result, the absolute mission success percentage is less meaningful than the relative differences across scenarios. For the purposes of this research, the focus is on how mission success changes when locations are removed and resupply is varied, not on achieving optimally calibrated absolute results. Improving the absolute fidelity of the baseline is identified as a future work item, ideally in collaboration with Systecon’s development team to explore how SIMLOX can better represent HADR demand natively.

Figure 4. ***SIMLOX Baseline: 65.55% Mission Success (Green), 34.45% Shortfall (Red)***

Degraded Network Scenarios

The degraded-network analysis examined three scenarios: the loss of Mainland Japan, the loss of Guam, and the loss of Pearl Harbor (Hawaii). For each scenario, SIMLOX was run with the affected location omitted and its platform systems reallocated to alternative locations under multiple resupply configurations. Because SIMLOX cannot natively simulate mobile delivery missions, the location-omission and system-reallocation workarounds described in the SIMLOX: Organic Use and HADR Workarounds Section were applied throughout. Results are presented comparatively against the baseline to isolate the operational cost of each location's loss and the relative effectiveness of alternate resupply strategies.

Scenario 1: Loss of Mainland Japan

Japan is the terminal hub for multiple supply chain paths, receiving stock from California, Subic Bay, Cebu, and Guam. Figure 5 compares mission success across four conditions: Baseline (65.55%), Relocate to Guam (48.41%), Dispersed Relocation (49.05%), and Relocate to California (45.95%).

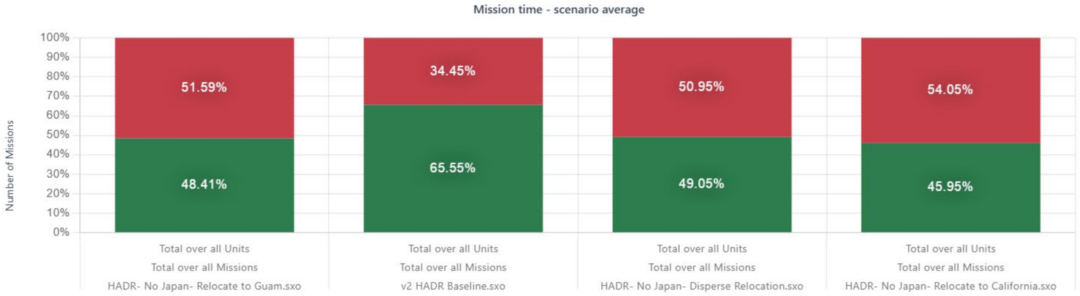


Figure 5. Loss of Japan: Baseline 65.55% | Relocate to Guam 48.41% | Dispersed 49.05% | Relocate to California 45.95%

Japan's loss produces the largest degradation of any scenario, approximately 16 to 20 percentage points below baseline, confirming it as the most critical single location. Guam (48.41%) and dispersed relocation (49.05%) both outperform California (45.95%), which is geographically intuitive: California's distance introduces long resupply lead times that the simulation window cannot absorb. Guam's proximity to Japan's operational area makes it the most effective single-source resupply point.

Scenario 2: Loss of Guam

Guam is the central mid-theater hub, connecting CONUS-sourced stock to the forward edge. Figure 6 compares five conditions: Baseline (65.55%), Dispersed (55.33%), Relocate to California (55.37%), Relocate to Japan (55.25%), Relocate to Pearl Harbor (56.02%).

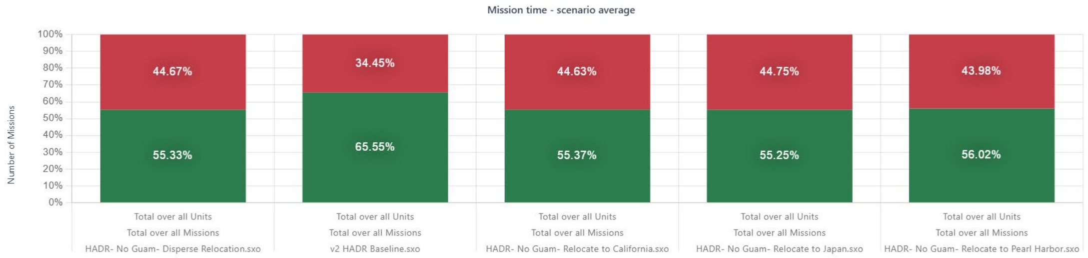


Figure 6. Loss of Guam: Baseline 65.55% | Dispersed 55.33% | Calif. 55.37% | Japan 55.25% | Pearl Harbor 56.02%

Guam's loss produces a more moderate degradation (~9–10 points below baseline). Most notably, all four resupply configurations perform nearly identically, within less than one percentage point of each other (55.25%–56.02%). This near-equivalence indicates that when Guam is lost, no single resupply source offers a decisive advantage. Pearl Harbor performs marginally best as the nearest upstream location. For planners, if Guam is unavailable, resupply source selection matters far less than ensuring adequate stock exists anywhere in the network.

Scenario 3: Loss of Pearl Harbor (Hawaii)

Pearl Harbor is the first forward relay from CONUS, redistributing California stock to Guam and beyond. Figure 7 compares four conditions: Baseline (65.55%), Dispersed (54.83%), Relocate to California (54.21%), Relocate to Japan (54.21%).

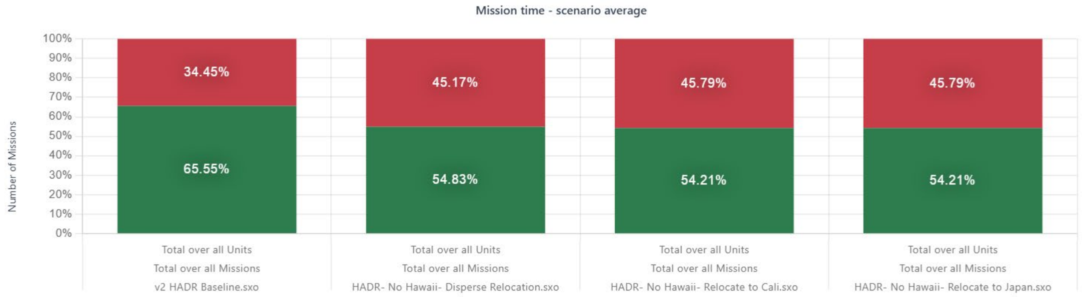


Figure 7. Loss of Pearl Harbor: Baseline 65.55% | Dispersed 54.83% | Calif. 54.21% | Japan 54.21%

Pearl Harbor's loss produces a degradation of approximately 10–11 points. Relocating its systems to California and Japan yields identical results (54.21%), a symmetry reflecting Pearl Harbor's pure relay role, where systems contribute equivalent network value regardless of whether they are sent upstream or downstream. Dispersed relocation (54.83%) performs marginally better, consistent with the distributed resilience principle seen across all scenarios.

Cross-Scenario Synthesis

Considered together, the three degraded-network scenarios yield several analytically significant conclusions. First, Mainland Japan is the most critical single location in the network: its loss produces the largest mission success degradation (approximately 17 percentage points below baseline) and the widest variation in resupply effectiveness across configurations. Guam and Pearl Harbor produce comparable and more moderate degradations (9 to 11 points), reflecting their importance as mid-theater relays without Japan's terminal hub criticality.

Second, geographic proximity of the resupply source matters most when the lost node is a terminal forward hub. For Japan, Guam's proximity advantage over California is clear and operationally meaningful (~2.5 percentage points). For Guam and Pearl Harbor, source proximity confers only marginal benefit.

Third, dispersed relocation generally matches or marginally outperforms the best single-source option in every scenario tested, but the advantage is small (less than one percentage point in most cases). While geographic distribution of resupply is prudent for resilience, the operational gain may not always justify coordination complexity in a time-critical HADR environment.

Finally, no resupply configuration in any scenario recovers the full baseline mission success rate. Pre-positioned forward stocks are operationally irreplaceable. Reactive resupply cannot fully compensate for the loss of a forward node.

A direction for future planning involves examining stocking levels more closely, specifically looking at how much additional stock would need to be held at alternate locations to increase mission success even when a primary location is unavailable. This optimization could help planners pre-position not only for normal operations but also for resilience against the loss of any single location.

Strategic Implications

Beyond its operational utility, this research has significant implications for how the DoW approaches HADR logistics within the broader strategic context of the Indo-Pacific.

HADR operations are not merely humanitarian in character. When the U.S. Navy responds rapidly and effectively to a natural disaster, it demonstrates operational reach and logistical credibility that strengthens security partnerships across the region. As Capie (2015) argues, HADR operations demonstrate an intervening country's level of commitment in a region, facilitate access to the recipient country, and offer opportunities for coalition-building and military interoperability. Operations Tomodachi and the Haiyan response generated substantial goodwill with Japan and the Philippines respectively, goodwill that has translated into expanded basing access, information sharing, and joint exercise participation.

A pre-positioned logistics framework optimized for HADR also has direct dual-use value. The same forward stockpiles, supply routes, and platform configurations that support disaster relief can, with modification, support distributed maritime operations, expeditionary logistics for conflict scenarios, and sustained presence operations. The RAND Corporation has noted that the DoW plays a major role in HADR operations due to its unique capabilities, manpower, and forward-deployed resources, and that the Asia-Pacific region is of particular importance given its disaster frequency and concentration of key U.S. allies (Moroney et al., 2013). Pre-positioning supplies at Guam, Subic Bay, and Japan is not merely a humanitarian investment; it is a contribution to the distributed sustainment architecture that underpins Department of Defense's broader Indo-Pacific posture.

Furthermore, demonstrating the ability to sustain a 168-hour HADR operation from forward stocks, without immediate CONUS resupply, signals logistics resilience that itself carries deterrent value. Adversaries and partners alike observe the U.S. military's ability to operate persistently and sustainably in the region, and logistics capability is a core component of that assessment.

Future Work

This research opens several avenues for further investigation that could extend and strengthen the analytical framework. Notably, the planning capability demonstrated here, using SIMLOX to simulate best locations for stock, systems, and resupply routing, can be expanded to optimize these locations across numerous scenarios in order to develop an operationally viable HADR network. This would identify where the best locations for equipment and supplies are positioned to enable rapid response, and how pre-positioning decisions can be stress-tested against a range of disaster types, severities, and infrastructure conditions across the Indo-PACOM theater.

Specific areas for further investigation include:

Integration of Real Historical Supply Data. The current failure rates are derived from general planning estimates. Future work should validate and refine these rates using after-action reports, logistics manifests, and supply requisition data from actual HADR operations including Tomodachi, Haiyan, and more recent events.

Expanded Platform Modeling. This research models four platform types. Future iterations could incorporate amphibious assault ships (LHD/LHA), landing ships (LSD/LPD), Maritime Prepositioning Force (MPF) vessels, and partner-nation platforms to more accurately represent the full logistics capacity available during a major HADR operation.

Cost-Benefit Optimization. Future work could integrate a cost dimension, enabling explicit tradeoff analysis between pre-positioning investment costs and response time benefits to identify the cost-optimal pre-positioning strategy.

Dynamic Scenario Generation. Future work could develop a probabilistic scenario generator drawing on historical disaster frequency data, population vulnerability assessments, and infrastructure fragility indices for Monte Carlo analysis within SIMLOX.

Interagency and Partner Nation Integration. Future modeling efforts should incorporate interagency partners (USAID, FEMA), partner nation militaries, and international organizations (UN OCHA, IFRC) as additional supply chain locations and capacity contributors.

Organic Integration with Opus Suite. Future work could collaborate with Systecon's development team to develop HADR-specific modules or parameterization templates, and to explore how SIMLOX's mission success output can better reflect HADR demand natively rather than relying on the parts-failure proxy used in this research.

Application to Other Geographic Commands. The framework is transferable to other combatant command areas of responsibility. AFRICOM, SOUTHCOM, and CENTCOM all face periodic HADR demands, and a parallel analysis could yield similarly actionable insights.

Iterative Scenario Planning and Off-the-Shelf HADR Plan Development. The Opus Suite framework developed in this research is not a one-time analysis; it is an iterative and repeatable planning tool. Just as military organizations regularly review and revise operational plans in response to new threats, emerging disaster patterns, changes in force structure, or the introduction of new platforms and systems, this framework can be updated and re-run to reflect those changes. New scenarios can be added, stocking locations adjusted, platforms swapped in or out, and consumption rates refined as better data becomes available. Each iteration produces an updated, optimized stocking solution and a fresh set of SIMLOX mission success curves, enabling planners to maintain a living HADR logistics plan that stays current with the operational environment. Over time, repeated application across the most likely disaster scenarios in the Indo-PACOM theater, drawing on historical frequency data and threat assessments, can produce an off-the-shelf HADR logistics plan: a pre-validated, scenario-specific playbook that commanders can reach for immediately when a disaster strikes, rather than building a logistics response from scratch under time pressure.

Physical Footprint and Storage Constraints as an Optimization Factor. The current modeling approach optimizes supply availability and mission success but does not account for the physical storage footprint of supplies at the point of need, a relevant constraint in the immediate post-disaster environment where staging space is severely limited. Future research will address this by incorporating pallet size and physical footprint as a third optimization dimension alongside cost and availability. Opus Suite's Opus Evo module is particularly well-suited to this expansion, as its evolutionary optimization algorithms can accommodate additional constraints and variables beyond the parameters available in OPUS10 alone. Using Opus Evo, future work can model how a supply chain must be structured to deliver the right quantities of materiel while respecting the storage limitations of a disaster-affected staging area, identifying configurations that balance logistical sufficiency with physical feasibility on the ground. It is worth noting that this constraint is most relevant in the immediate response phase. Once ship-borne supplies are involved, the storage limitation largely becomes moot, as the ship itself serves as the floating warehouse and supplies are distributed from the vessel rather than accumulated at a land-based staging point. The footprint optimization problem is therefore concentrated in the earliest hours of a response and in scenarios where shore-based staging is the primary distribution mechanism.

Conclusion

This research presents a novel application of the Opus Suite (specifically OPUS10 and SIMLOX) to the challenge of optimizing Navy logistics strategies for humanitarian assistance and disaster relief operations in the Indo-Pacific. By modeling supply chains, failure rates, and platform capacities within a multi-echelon optimization and simulation framework, this work provides a quantitative, scenario-driven basis for the pre-positioning decision that has historically been made through heuristic judgment alone.

The analysis demonstrates that the OPUS10-optimized pre-positioning solution provides a viable baseline for sustained HADR operations across the Indo-Pacific. SIMLOX degraded-network scenarios reveal which forward locations are most critical to sustained mission success, and which resupply sources, individually or in combination, are most effective at restoring performance when those locations are lost. Multi-source resupply consistently performs at or near the top across scenarios, and the findings highlight the strategic value of geographic redundancy in forward stock placement.

Perhaps most significantly, this research demonstrates that rigorous analytical tools can be creatively adapted beyond their original design envelopes. Opus Suite was not built for humanitarian logistics, but with thoughtful parameterization, it yields actionable insights that can inform real acquisition and pre-positioning decisions. This methodological contribution may be as valuable as the specific results it produces.

The Navy's role in Indo-Pacific HADR operations is both a humanitarian responsibility and a strategic opportunity. A logistics framework that enables faster, more reliable, and more resilient humanitarian response will not only save lives in the next disaster and strengthen the alliances, demonstrate the capabilities, and build the logistical infrastructure that underpin American strategic advantage in the Indo-Pacific for decades to come.

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