



EXCERPT FROM THE
PROCEEDINGS
OF THE
TWENTY-THIRD ANNUAL
ACQUISITION RESEARCH SYMPOSIUM AND
INNOVATION SUMMIT

THURSDAY, MAY 7, 2026 SESSIONS
VOLUME II

“ACCELERATING WARFIGHTING CAPABILITIES”

**Constructing a Logistics Hub through the
Integration of Remote Border Islands and
Offshore Ocean Platforms**

Published: April 30, 2026

Approved for public release; distribution is unlimited.

Prepared for the Naval Postgraduate School, Monterey, CA 93943.

Disclaimer: The views expressed are those of the author(s) and do not reflect the official policy or position of the Naval Postgraduate School, US Navy, Department of Defense, or the US government.



The research presented in this report was supported by the Acquisition Research Program, Graduate School of Defense Management at the Naval Postgraduate School.

To request defense acquisition research, please contact:

Acquisition Research Program
Department of Defense Management
Naval Postgraduate School
E: arp@nps.edu
www.acquisitionresearch.net

Copies of Symposium Proceedings and Presentations; and Acquisition Sponsored Faculty and Student Research Reports and Posters may be printed from the **NPS Defense Acquisition & Innovation Repository** at <https://dair.nps.edu/>.



ACQUISITION RESEARCH PROGRAM
DEPARTMENT OF ACQUISITION, FINANCE, AND MANPOWER
NAVAL POSTGRADUATE SCHOOL

Constructing a Logistics Hub through the Integration of Remote Border Islands and Offshore Ocean Platforms

Captain Atsushi Yanagita—is currently the Director of the Future Warfare and Logistics Studies Office at the Japan Maritime Self-Defense Force (JMSDF) Command and Staff College as well as a doctoral student in the Postgraduate School of Applied Environmental Systems at the Tokyo University of Marine Science and Technology. [y_atsushi1@inet.msdf.mod.go.jp, atsushi.yanagita@piano.ocn.ne.jp]

Abstract

This study examines whether a relay-based hybrid hub linking Japan's remote border islands with offshore ocean platforms can improve logistics performance in the Western Pacific under contested and disrupted conditions. Focusing on Minamitori Island and Okinotori Island, it addresses the sustainment gap between Japan, Guam, and Hawaii by comparing direct-route and relay-route models across six military and disaster-response scenarios. The concept is evaluated using four key performance indicators: Delivery, Distribution, Resilience, and Sustainment. Results indicate that relay routing consistently outperforms direct transport, especially in severe conditions. In the high-threat scenario, delivery probability rises from 47.9% to 65.6%, operational availability from 53.2% to 71.7%, and forward Days of Supply by about 2–3.5 days. These gains derive from a 72-hour buffer that absorbs disruption, supports limited inspection and repair, and enables redistribution in smaller lots. The study concludes that resilience through distribution provides a practical and scalable framework for sustaining maritime operations in contested environments.

Introduction

The principal Sea Lines of Communication (SLOCs) that support U.S. and allied maritime operations in the Indo-Pacific form a long and exposed arc extending from the continental United States through Hawaii and Guam to Japan. In the Western Pacific, this geography creates a persistent logistics problem: sustainment must be delivered across long distances, through harsh maritime conditions, and under the growing possibility of disruption by anti-access/area-denial (A2/AD) threats. The issue is therefore not simply how to replenish forces at sea, but how to preserve delivery reliability and sustainment endurance when routes are delayed, degraded, or contested.

At the center of this problem lies a specific operational gap. Between Japan, Guam, and Hawaii, there are few intermediate sustainment nodes capable of receiving, holding, redistributing, or recovering logistics flows. As a result, operational logistics remain heavily dependent on direct delivery and return-to-homeport cycles. This dependence reduces redundancy, constrains routing flexibility, and increases the likelihood that weather, port closures, mechanical interruptions, or hostile action will translate directly into a mission-level logistics failure.

Within this theater, Minamitori Island and Okinotori Island occupy positions of unusual strategic relevance. As remote Japanese border islands, they contribute to sovereignty, maritime domain awareness, and the maintenance of Japan's extensive Exclusive Economic Zone (EEZ). They also present a largely underdeveloped opportunity for distributed sustainment. Japanese policy has already supported incremental infrastructure development on remote islands, including berthing, mooring, and limited port functions. At the same time, Japan's National Defense Strategy and Defense Buildup Program, both issued in 2022, emphasize resilience, sustainment, automation, and manpower-efficient capability design. Taken together, these trends suggest that remote islands should be considered not only as



symbolic or administrative outposts, but also as potential components of an operational logistics architecture.

Yet an important gap remains between policy direction and operational design. While current defense and infrastructure policies support resilience and remote-island development in general terms, they do not by themselves provide a concrete sustainment architecture for the mid-ocean logistics gap in the Western Pacific. Existing afloat logistics capabilities, including Combat Logistics Force operations, underway replenishment, and broader sea-basing concepts, remain indispensable. However, they continue to depend heavily on secure access to ports, airfields, anchorages, and fixed support infrastructure. In a disrupted or contested environment, those dependencies may become critical vulnerabilities rather than reliable enablers.

This study addresses that gap by proposing a relay-based hybrid logistics hub that integrates remote border islands with offshore ocean platforms. Rather than treating Minamitori Island and Okinotori Island as isolated points, the concept treats them as distributed sustainment nodes within a wider network linking Japan, Guam, Hawaii, and Okinawa. The core operational logic is straightforward: by inserting intermediate nodes capable of pre-positioning supplies, absorbing temporary disruption, enabling limited maintenance, and supporting onward redistribution, the logistics system can convert some forms of mission-ending delivery failure into manageable delay. In this sense, the concept is not designed primarily to maximize peacetime efficiency, but to preserve continuity under conditions of friction.

Because the maritime environment around both islands is characterized by typhoons, high sea states, and limited fixed infrastructure, the proposed architecture emphasizes mobility, modularity, and survivability. It therefore considers hybrid offshore support forms, including semi-submersible structures and Floating Production, Storage, and Offloading (FPSO)-derived configurations, as part of a scalable sustainment design. This approach is consistent with the logic of Distributed Maritime Operations (DMO), Expeditionary Advanced Base Operations (EABO), and contested logistics more broadly: combat power and sustainment capacity must be dispersed, adaptable, and able to recover under disruption rather than concentrated in a small number of fixed locations.

Against that background, this paper addresses two research questions. First, to what extent can a relay-based hybrid hub integrating remote border islands and offshore platforms improve logistics effectiveness in the Western Pacific under contested conditions? Second, which design features most strongly shape that effectiveness, particularly redundancy, rerouting capability, autonomy and uncrewed operations, and semi-submersible offshore storage?

To answer these questions, the paper evaluates the proposed concept through four key performance indicators (KPIs): Delivery, Distribution, Resilience, and Sustainment. Delivery refers to the probability that supplies successfully arrive at the forward destination. Distribution refers to the probability that at least one logistics route remains viable under disruption. Resilience refers to operational availability under degraded conditions. Sustainment refers to forward Days of Supply (DOS), or the duration for which operational demand can be covered at the forward edge. Together, these measures allow the analysis to assess not merely whether the concept is feasible in engineering terms, but whether it materially improves logistics performance under high-friction conditions.

This paper identifies the mid-ocean sustainment gap, proposes a relay-based hybrid hub linking remote islands and offshore platforms, and evaluates its effects on delivery assurance, routing robustness, operational continuity, and forward sustainment.



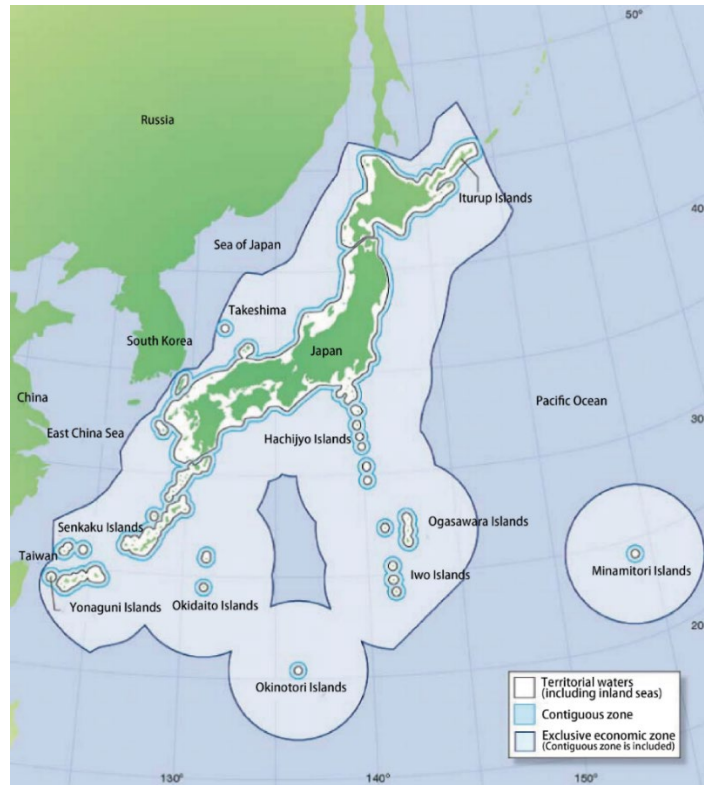


Figure 1. Japan's EEZ and Border Islands-

Problem Statement and Analytical Framework

Background and Problem Definition

Remote border islands are commonly understood as instruments of sovereignty, maritime security, and resource governance. In Japan's case, these functions are supported through a combination of legal authority, infrastructure investment, and administrative continuity. The Act on Special Measures for the Preservation of Remote Border Islands and related infrastructure programs have sustained habitation, transportation access, and basic port functions on selected islands. These measures are important not only for territorial administration, but also because they preserve the minimum physical and institutional conditions from which future sustainment functions may develop.

For the purposes of this study, however, the significance of remote islands is not primarily legal or symbolic. It is operational. In the Western Pacific, long sea distances, severe weather exposure, limited intermediate port capacity, and the growing possibility of disruption under anti-access/area-denial (A2/AD) conditions combine to undermine logistics reliability. Under these conditions, the central problem is not merely the movement of supplies from origin to destination, but the absence of intermediate nodes capable of receiving, holding, redistributing, and recovering logistics flows when direct delivery is delayed or interrupted.

Japan's recent defense policy sharpens this requirement. The National Defense Strategy, the Defense Buildup Program, and subsequent white papers place resilience, sustainment, automation, and manpower efficiency near the center of future force design. Read operationally, these documents imply two requirements. First, logistics systems must reduce excessive dependence on a small number of fixed bases. Second, they must become more capable of integrating civilian transportation capacity, modular infrastructure, and remote or low-manning

support functions under appropriate legal and command arrangements. Yet policy direction alone does not resolve the theater-level architecture problem. The question remains how these principles should be translated into a practical sustainment network across the mid-ocean gap of the Western Pacific.

This paper defines that gap as a network problem. Existing logistics systems remain overly dependent on direct delivery and return-to-homeport cycles. Such dependence constrains routing options, limits redundancy, and makes disruption disproportionately costly. Weather, port denial, mechanical interruption, or hostile action can therefore quickly propagate from local friction to theater-level sustainment failure. The problem addressed here is how to reduce that fragility through a distributed architecture centered on relay-based hybrid hubs linking remote islands and offshore support forms.

Prior Research and Theoretical Lineage

The proposed concept is grounded in a long intellectual tradition in logistics and maritime operations. Classical logistics thought identified the enduring relationship between lines of operation, bases, and combat endurance. Jomini (1862) emphasized the strategic importance of lines of communication. Thorpe (1986) treated logistics as a national function re-quiring advanced preparation and coordination. Eccles (1959), writing from a naval perspective, argued that maritime operations can be sustained only through effective bases and supply systems. Across these traditions, a common proposition emerges: operational endurance depends not simply on the quantity of supply, but on the structure and reliability of the network that connects routes, nodes, and time.

Contemporary doctrine extends this logic rather than replacing it. Distributed Maritime Operations (DMO), Expeditionary Advanced Base Operations (EABO), sea-basing concepts, and the wider focus on contested logistics all point toward the same analytical conclusion: sustainment must be dispersed, adaptive, and resilient under conditions of disruption. In this respect, logistics architecture becomes a warfighting variable rather than a purely administrative function. The value of distribution lies not only in efficiency, but in preserving operational continuity when access is degraded, timing is uncertain, and attrition or interruption is expected.

At the same time, an important gap remains in the literature and in practical design. Existing research has not sufficiently integrated Japan's remote border islands—particularly Minamitori Island and Okinotori Island—with offshore ocean platforms as a combined sustainment architecture. Nor has prior work adequately linked such a concept to questions of phased implementation, acquisition feasibility, and measurable logistics performance. This study, therefore, builds on the theoretical lineage of logistics and current operational doctrine while addressing a specific applied problem that remains underdeveloped in the existing literature.

Research Questions (RQs) and KPIs

From this problem setting, two research questions follow.

- RQ-1: To what extent can a relay-based hybrid hub integrating remote border islands and offshore platforms improve logistics effectiveness in the Western Pacific under contested conditions?
- RQ-2: Which design features most strongly shape that effectiveness, particularly redundancy, rerouting capability, autonomy, and uncrewed operations, and semi-submersible off-shore storage?

These questions reflect a deliberate analytical sequence. The first question asks whether the proposed concept improves system performance relative to more direct, less distributed logistics arrangements. The second asks why such improvement occurs and which design



attributes are most responsible for it. In other words, RQ-1 addresses comparative effectiveness, while RQ-2 addresses causal design significance.

The study's analytical logic is based on a network view of sustainment. The effectiveness of the proposed concept depends less on the absolute capacity of any single island or platform than on the network's ability to absorb disruption, preserve routing options, and maintain forward support over time. For that reason, the analysis treats modularity, dispersal, redundancy, and rapid re-tasking not as secondary engineering preferences, but as primary operational variables.

Key Performance Indicators and Evaluation Criteria

To evaluate the research questions, the study uses four key performance indicators (KPIs): Delivery, Distribution, Resilience, and Sustainment. In combination, these metrics capture both the immediate and cumulative effects of logistics architecture under contested conditions. The purpose is not merely to test whether supplies can move, but also to determine whether the system can continue functioning when exposed to friction, delay, and partial disruption.

These KPIs are analytically complementary. Delivery captures arrival success. Distribution captures route survivability. Resilience captures continuity under degradation. Sustainment captures temporal depth. Taken together, they provide a practical framework for comparing direct-delivery and relay-based logistics architectures in a theater where disruption is expected rather than exceptional.

Operational Constraints and Research Implications

The Western Pacific logistics problem is shaped by four interacting constraints: distance, weather, threat, and limited port capacity. These constraints do not operate independently. Instead, they reinforce one another. Long transit distances increase exposure time, severe sea states reduce schedule reliability, limited ports compress rerouting options, and threat conditions magnify the operational consequences of delay or concentration. The result is a logistics environment in which friction accumulates and is often nonlinear.

This has two implications for the present study. First, the relevant measure of effectiveness is not simply throughput under ideal conditions, but performance under disruption. Second, logistics resilience must be treated as a network property rather than as a feature of a single platform or facility. A contested logistics architecture succeeds when it can absorb delay, preserve at least partial functionality, and maintain forward momentum despite degraded conditions. For that reason, the analysis in the following sections emphasizes distributed sustainment nodes, pre-positioning, rerouting, modular support, and delay absorption as the principal mechanisms through which remote-island and offshore logistics hubs may improve theater sustainment.

Operational Environment and Geographic Conditions

Operational Concepts and Logistics Requirements

In the Indo-Pacific, logistics effectiveness is shaped by distance, exposure, and the ability to sustain forward forces amid uncertainty. Operational reach depends not only on lift capacity but also on whether supplies can be moved, held, redistributed, and recovered across long, vulnerable sea lines of communication (SLOCs). In this theater, contested logistics is therefore a problem of network performance rather than simple throughput. The key question is whether the sustainment system can preserve continuity when weather, sea-state conditions, port access limitations, mechanical interruption, or hostile action disrupt normal movement.

This requirement is consistent with the operational logic of Distributed Maritime Operations (DMO) and Expeditionary Advanced Base Operations (EABO). Both concepts seek



to dis-purse combat power and supporting functions in ways that complicate adversary targeting while preserving mission effectiveness. From a logistics perspective, this implies more than additional shipping or larger inventories. It requires a distributed sustainment architecture composed of intermediate nodes, pre-positioned stocks, flexible command-and-control (C2), and the ability to reprioritize and reroute support under degraded conditions. In other words, sustainment must be designed not only for efficiency in routine conditions, but for recovery and continuity under friction.

The Western Pacific places unusual pressure on this requirement. Transit distances are long, exposure times are extended, and the number of usable intermediate logistics locations remains limited. As a result, direct delivery often becomes the default operating model. That model can function in permissive conditions, but it becomes increasingly brittle when even modest disruption accumulates across multiple variables. The operational value of an intermediate relay node is therefore not simply geographic convenience. It lies in the ability to convert disruption from mission termination into bounded delay, while preserving options for onward movement and local recovery. This is the operational requirement against which Minamitori Island and Okinotori Island are assessed in the present study.

Geographic Characteristics of Minamitori Island and Okinotori Island

Minamitori Island offers comparatively favorable conditions for the development of an initial logistics node. Existing facilities, anchorage potential, and limited air and sea access make it more suitable as a first-step site for phased logistics expansion. Relative to more austere offshore locations, it presents a more practical environment for introducing pre-positioned stocks, transshipment functions, light maintenance support, and command-and-control connectivity. In analytical terms, Minamitori Island is significant because it can serve as a feasible entry point for a distributed sustainment architecture rather than requiring a fully mature offshore system from the outset. Okinotori Island presents a markedly different operating environment. It is more austere, more environmentally demanding, and less suited to conventional fixed-facility development. These conditions increase the relative value of offshore, modular, semi-submersible, and FPSO-derived support forms. In this setting, the central engineering problem is not how to reproduce a conventional port, but how to provide logistics persistence under severe maritime conditions with limited permanent infrastructure. The importance of Okinotori Island, therefore, lies less in fixed basing potential than in its role as a location where survivable and relocatable offshore support concepts become operationally relevant.

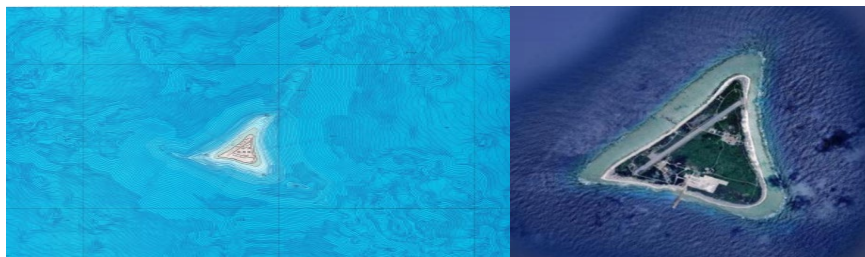


Figure 2. Minamitori Island

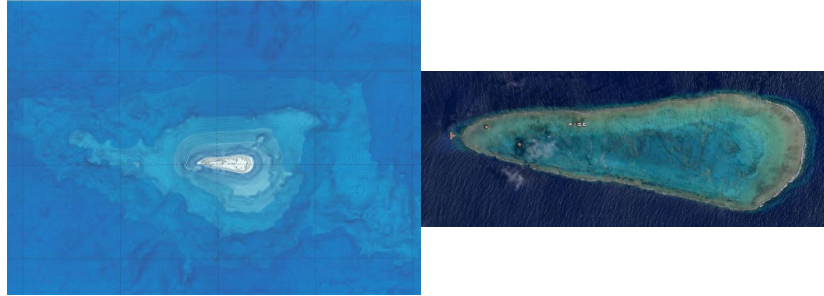


Figure 3. Okinotori Island

The contrast between the two islands is analytically useful. Minamitori Island represents a comparatively accessible and developmentally realistic node for early implementation. Okinotori Island represents the more demanding edge case that tests the necessity of modularity, mobility, and survivability. Taken together, they define a scalable design spectrum for Western Pacific logistics: one anchored in practical phased development, and the other in engineering adaptation to austere and contested maritime conditions. This duality is central to the concept developed in the following chapter.

Both islands are also significant at the theater level. Beyond their sovereignty and Exclusive Economic Zone (EEZ) functions, they may serve as intermediate connectors within a wider allied and partner logistics network linking Japan, Guam, Hawaii, and forward operating areas such as Okinawa. Their value is therefore not reducible to local infrastructure alone. It emerges from their position within a broader network of routes, stocks, and relay functions across the Western Pacific.

Strategic Significance as a Western Pacific Logistics Hub

The strategic significance of a logistics hub centered on Minamitori Island and Okinotori Island is best understood through the four key performance indicators used in this study: Delivery, Distribution, Resilience, and Sustainment. The value of the concept lies not in any single engineering feature, but in the way geographic position and hybrid-node design affect all four dimensions of logistics performance.

First, Delivery may improve because the islands and their associated offshore platforms can function as forward replenishment and redistribution nodes. By inserting an intermediate node between origin and destination, the network reduces exclusive reliance on uninterrupted direct delivery. This enables greater ability to absorb delays, stage critical supplies in advance, and shorten the effective response cycle for onward movement to the forward edge.

Second, Distribution may improve because the combination of island facilities with floating, semi-submersible, and FPSO-derived platforms increases routing flexibility. A hybrid architecture creates multiple support forms rather than a single point of dependence. In a disrupted environment, that redundancy matters because the probability of maintaining at least one viable route or node is often more important than the nominal capacity of any one facility.

Third, Resilience may improve because semi-submersible and modular offshore support structures are potentially more tolerant of severe weather, partial damage, and access degradation than conventional fixed-port assumptions would suggest. In an environment where disruption is expected, the ability to maintain partial functionality and recover operational availability becomes a core source of advantage. For this reason, survivability should be treated not only as a platform attribute, but as a logistics-network attribute.

Fourth, Sustainment may improve because pre-positioned stocks and local replenishment cycles at these nodes increase forward Days of Supply (DOS). In practical terms, this extends the time forward forces can operate without immediate reliance on long-haul resupply from rear bases. The concept, therefore, improves not only movement reliability but also endurance at the point of operational need.

Taken together, these implications show why the geographic characteristics of Minamitori Island and Okinotori Island matter strategically. Their significance does not arise merely from location on a map. It arises from the combination of geographic position, infrastructure potential, offshore engineering adaptability, and network function. In that sense, they should be understood not as isolated outposts, but as candidate relay nodes in a broader theater sustainment architecture.

Architecture of the Logistics Hub

Design Philosophy and Minimum Viable Product (MVP)

The proposed logistics hub should be understood not as a single fixed installation, but as a distributed, scalable architecture that combines remote-island infrastructure with offshore support systems. Its central design logic is evolutionary rather than static. Instead of seeking to construct a fully mature offshore base from the outset, the concept begins with a minimum viable architecture capable of producing operationally meaningful improvement in logistics performance under disrupted conditions and then expands in phases as legal arrangements, technical confidence, and mission demand mature. This design philosophy is consistent with contested logistics, where early functionality, adaptability, and survivability are often more valuable than initial completeness.

For the purposes of this study, the minimum viable product (MVP) is defined not by physical size, but by functional sufficiency. A node qualifies as operationally meaningful when it can do more than merely hold cargo. At a minimum, the initial architecture must be able to receive supplies, hold them safely for short periods, redistribute them onward, support limited inspection and light recovery functions, and maintain enough communications and monitoring capacity to operate remotely under degraded conditions. In practical terms, the MVP serves as the first relay point in a broader sustainment network. Its purpose is not to replicate a conventional port, but to create a node that can absorb disruption and preserve continuity.

This framing has two important implications. First, the architecture is optimized initially for operational usefulness rather than permanence. Second, capability growth should be evaluated by measurable gains in Delivery, Distribution, Resilience, and Sustainment rather than by construction scale alone. In this sense, the logistics hub is best understood as a performance-based architecture whose value depends on what functions it enables across the network, not simply on the amount of infrastructure emplaced at a single location.

Structural Portfolio and Operational Fit




The proposed hub can be realized through multiple structural forms, each contributing differently to logistics performance. The central architectural question is therefore not which single structure is best, but how a portfolio of structures can be combined so that each offsets the others' limitations while contributing to the four key performance indicators. The relevant structural categories in this study are fixed island or pier-type facilities, floating barges and modular pontoons, semi-submersible platforms, and FPSO-derived structures such as converted tankers.


Taken together, these structural options indicate that the logistics hub is best treated as a portfolio design problem. Minamitori Island is better suited to phased development that begins



with fixed and modular floating elements, whereas Okinotori Island is more naturally aligned with offshore-first configurations centered on semi-submersible and FPSO-derived support forms. This distinction follows directly from the differences in access, environmental severity, and infrastructure potential identified in the previous chapter.

Table 1. Structural Typology (Synopsis)

Structure Type	Primary Functional Significance	KPI(s)
<p>Fixed: artificial island/pier</p> 	<p>Fixed structures provide continuity, visibility, and political legitimacy. They are especially useful where stable access, routine transfer, and a visible sovereign presence are required. Their principal advantage lies in delivery assurance under relatively controlled conditions. Their principal weakness is their least adaptability and potential vulnerability to both adversary targeting and environmental stress. For that reason, they should be treated as one element of the architecture rather than its complete solution.</p>	<p>Delivery</p>
<p>Floating: barge / modular pontoon</p> 	<p>Floating barges and modular pontoons provide rapid fielding, flexible augmentation, and lower barriers to modification. These attributes make them attractive in early implementation phases, when rapid delivery capacity and basic distribution flexibility are more important than full survivability. They are especially useful for establishing an initial logistics presence at a lower cost and with shorter lead times. Their limitations become more apparent in severe maritime conditions, where endurance and survivability are weaker than those of more specialized offshore forms.</p>	<p>Delivery / Distribution</p>
<p>Semi-submersible</p> 	<p>Semi-submersible platforms become more important as weather survivability and operational continuity become central design drivers. Their relative stability in high sea states, lower visibility profile, and greater tolerance of severe maritime conditions make them particularly relevant to resilience. In austere environments such as Okinotori Island, where a conventional fixed-facility solution is less feasible, semi-submersible forms offer a practical way to preserve logistics functionality when simpler floating structures may be forced to suspend operations.</p>	<p>Resilience / Sustainment</p>

<p>FPSO-derived (converted tanker)</p> 	<p>FPSO-derived structures add bulk storage and sustained offshore support capacity. Their main value lies in fuel, water, and critical materiel storage, as well as in their capacity to support repeated redistribution cycles. They therefore strengthen sustainment depth and distribution endurance more than political visibility or symbolic presence. Within the larger portfolio, they serve as the backbone of offshore sustainment rather than as the entire hub concept on their own.</p>	<p>Sustainment / Distribution</p>
--	---	-----------------------------------

Required Functions and Their KPI Relevance

From an operational standpoint, the architecture must perform four core functions: access, storage, maintenance, and management. These categories are not merely engineering descriptors. They are the practical mechanisms through which the hub improves logistics performance under contested or disrupted conditions.

- **Access** includes berthing and mooring, fuel and water transfer, container handling, and lighterage. These functions are foundational because no relay architecture can work unless cargo can be received and moved onward reliably. Access, therefore, maps most directly to Delivery.
- **Storage** includes automated warehousing, unmanned fuel tanks, and containerized stockholding. Storage matters because it decouples inbound and outbound movement. In other words, it allows the hub to absorb temporary disruption rather than forcing immediate mission failure when onward movement is delayed. Storage therefore strengthens both Distribution and Sustainment.
- **Maintenance** includes recovery, inspection, charging, relaunch, and limited repair capability for uncrewed systems and selected equipment. These functions reduce effective down-time, restore degraded capability, and shorten turnaround time. Maintenance, therefore, contributes directly to Resilience.
- **Management** includes communications control, medical support, berthing coordination, and power generation. Communications are particularly critical because the hub must operate under remote, distributed, and sometimes unmanned conditions. A multi-path communications architecture—combining satellite, HF, optical, and other available means—improves continuity under degraded conditions. Similarly, hybrid energy arrangements strengthen endurance in routine operations while preserving resilience during crisis or severe weather. Management, therefore, is the integrating function that allows the node to behave as an active part of a logistics network rather than as a passive storage point.

Phased Capability Development

Because legal authority, technical maturity, operational concepts, and contracting mechanisms will not mature at the same pace, the proposed architecture should be developed in phases. The phased growth model in this study begins with an initial fielded MVP largely based on civilian technology, with an emphasis on legal compliance, safety, and a rapid-delivery baseline. It then expands to include fuel, water, and maintenance functions, followed by larger warehousing and management capacity, and finally advanced communications and autonomous control that support performance across all four KPIs.



This should not be interpreted as a simple equipment sequence. It is better understood as a spiral development process in which operational employment, policy adaptation, safety regulation, engineering choices, and data infrastructure mature together. That point is especially important from an acquisition perspective. The challenge is not merely to procure a set of platforms, but to build an integrated sustainment system whose legal, technical, and operational components become progressively more capable and mutually reinforcing over time.

Phased development also provides a practical response to uncertainty. It allows the architecture to begin with achievable capabilities, generate early operational utility, and then adapt based on evidence about which combinations of structures and functions produce the greatest improvement in Delivery, Distribution, Resilience, and Sustainment. In this respect, phased growth is not only an implementation strategy. It is also an analytical strategy that supports iterative learning under real-world constraints.

Architectural Significance

The central implication of this chapter is that the proposed logistics hub should be understood as a distributed, layered, and adaptive sustainment system rather than as a single offshore installation. Fixed infrastructure provides continuity and legitimacy. Floating modular elements provide rapid fielding and flexible augmentation. Semi-submersible structures provide survivability under severe environmental and threat conditions. FPSO-derived assets provide sustainment depth through bulk offshore storage and the capacity for repeated redistribution. The value of the architecture does not lie in any one of these forms alone, but in the way they are combined to generate network effects greater than those of any single structure.

This design logic establishes the basis for the analytical chapter that follows. If the architecture is valid, its effects should be visible not only in engineering feasibility but also in measurable changes to logistics performance across different operational scenarios. The next chapter, therefore, evaluates whether the proposed relay-based hybrid hub actually changes the dominant failure mode of logistics operations from mission-ending non-delivery to bounded and operationally manageable delay, and whether that shift yields meaningful gains across the four key performance indicators.

Scenarios and Evaluation

Analytical Purpose and Comparative Design

This chapter evaluates whether a relay-based hybrid hub improves logistics performance in the Western Pacific relative to a direct-route baseline. The comparison is made between two routing constructs. The first is a direct-route model, in which cargo moves from the origin to the destination without passing through an intermediate node. The second is a relay-route model, in which Minamitori Island and Okinotori Island function as intermediate distributed sustainment nodes (DSNs) that absorb disruption, support limited maintenance, and enable onward redistribution. The analytical objective is to determine whether the relay construct shifts the dominant failure mode of logistics operations from mission-ending non-delivery to bounded delay that can be managed operationally.

To test that proposition, the analysis uses two scenario families. The military scenarios (M-series) represent progressively more contested operating environments, while the non-military scenarios (C-series) represent escalating disruption in civil and disaster-response conditions. Across both families, the comparison remains the same: whether relay routing preserves delivery, resilience, and sustainment more effectively than direct transport as operational friction increases.



Measures of Effectiveness

The concept is evaluated through four key performance indicators (KPIs): Delivery, Distribution, Resilience, and Sustainment. Delivery is defined as the probability that supplies successfully arrive at Okinawa. Distribution is defined as the probability that at least one logistics route remains viable under disruption. Resilience is defined as operational availability under degraded conditions. Sustainment is defined as forward Days of Supply (DOS), that is, how long operational demand at the forward destination can be covered. Together, these KPIs enable evaluation of the proposed hub not merely as infrastructure, but as a comparative sustainment architecture under contested and disrupted conditions.

Scenario Families

To preserve internal consistency across the six scenarios, the comparative model uses a common set of scenario-specific representative assumptions. These values are not presented as universal constants or fleet-wide empirical rates. Rather, they are structured analytical inputs used to generate the comparative outputs reported in Table 3.

Weather disruption probability is set at 0.03 / 0.03 / 0.10 for M-1/M-2/M-3 and 0.03 / 0.15 / 0.15 for C-1/C-2/C-3.

Port disruption probability is set at 0.02 / 0.10 / 0.30 for M-1/M-2/M-3 and 0.02 / 0.20 / 0.15 for C-1/C-2/C-3. The share of disruptions exceeding the 72-hour holding buffer is set at 0.10 / 0.20 / 0.40 for M-1/M-2/M-3 and 0.10 / 0.30 / 0.50 for C-1/C-2/C-3.

Mechanical failure probability varies by routing construct: for military scenarios, direct values are 0.0198 / 0.0257 / 0.0488, and relay values are 0.0150 / 0.0180 / 0.0300; for non-military scenarios, direct values are 0.0060 / 0.0072 / 0.0084, and relay values are 0.0050 / 0.0065 / 0.0075.

Threat-related disruption is applied only in military scenarios and is set at 0.055 / 0.090 / 0.200 for M-1/M-2/M-3, whereas in non-military scenarios, the threat is set to zero.

These assumptions reflect the paper's routing logic. In the direct case, weather, port closures, mechanical interruptions, and threats are treated as immediate causes of mission failure. In the relay case, only the share of weather- and port-related disruptions that exceed the 72-hour hold window remains mission-ending, while inspection and light repair at the intermediate node reduce the effective mechanical-interruption rate.



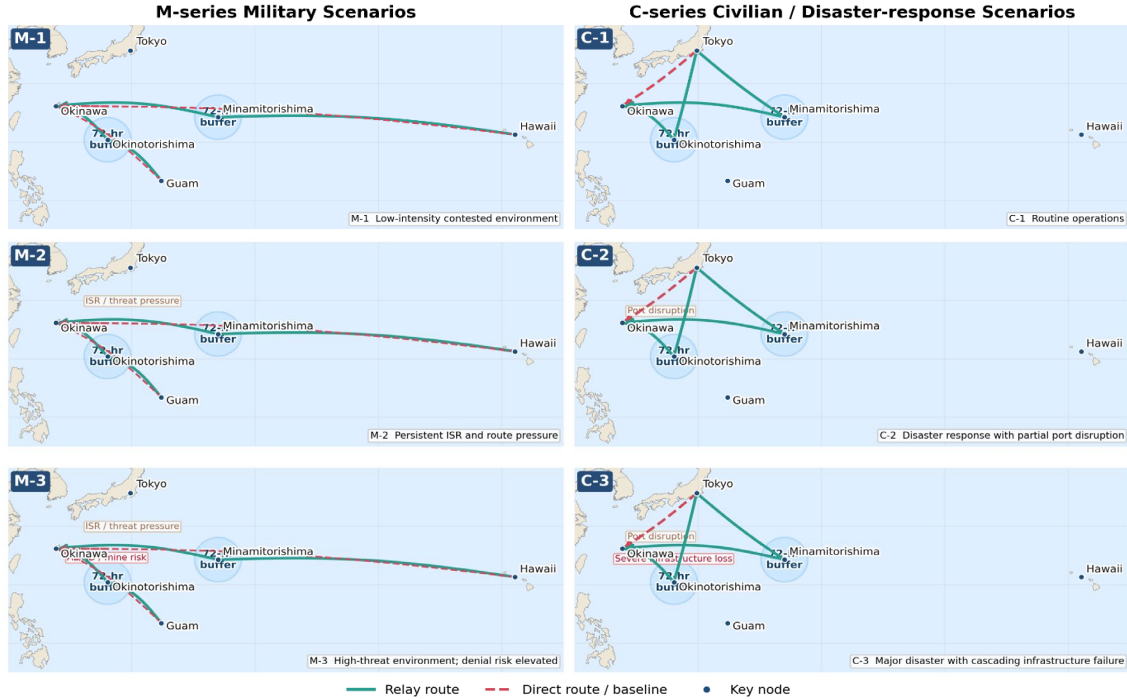


Figure 4. Military Scenario (M-Series) and Non-Military Scenario (C-Series)

Comparative Calculation Logic

Delivery

Delivery is modeled as the probability that supplies successfully reach Okinawa. For the direct-route construct in scenarios, arrival probability is defined as

$$D_s^{\text{direct}} = (1 - W_s)(1 - M_s^{\text{direct}})(1 - P_s)(1 - T_s) \quad (1)$$

where W_s is weather disruption probability, M_s^{direct} is direct-case mechanical failure probability, P_s is port disruption probability, and T_s is threat-related disruption probability. This is a series-reliability formulation: if any one of these factors causes mission non-completion, delivery fails.

For the relay-route construct, the same baseline risk categories apply, but the 72-hour holding buffer changes the treatment of weather and port effects, and relay-node inspection/light repair reduces the mechanical interruption rate. Arrival probability is therefore defined as

$$D_s^{\text{relay}} = (1 - \alpha_s W_s)(1 - M_s^{\text{relay}})(1 - \alpha_s P_s)(1 - T_s) \quad (2)$$

where α_s is the share of weather- and port-related disruptions exceeding the 72-hour hold window and M_s^{relay} is relay-case mechanical failure probability after inspection and light repair at the intermediate node. For non-military scenarios, $T_s = 0$. This formulation captures the central mechanism of the relay concept: part of the disruption is no longer counted as immediate non-delivery.

Using the representative assumptions above, the model reproduces the Delivery values shown in Table 3.

For M-1:

$$D_{M1}^{\text{direct}} = (1 - 0.03)(1 - 0.0198)(1 - 0.02)(1 - 0.055) = 0.881$$

$$D_{M1}^{\text{relay}} = (1 - 0.10 \times 0.03)(1 - 0.0150)(1 - 0.10 \times 0.02)(1 - 0.055) = 0.92$$

For M-2:

$$D_{M2}^{\text{direct}} = (1 - 0.03)(1 - 0.0257)(1 - 0.10)(1 - 0.090) = 0.774$$

$$D_{M2}^{\text{relay}} = (1 - 0.20 \times 0.03)(1 - 0.0180)(1 - 0.20 \times 0.10)(1 - 0.090) = 0.870$$

For M-3:

$$D_{M3}^{\text{direct}} = (1 - 0.10)(1 - 0.0488)(1 - 0.30)(1 - 0.200) = 0.479$$

$$D_{M3}^{\text{relay}} = (1 - 0.40 \times 0.10)(1 - 0.0300)(1 - 0.40 \times 0.30)(1 - 0.200) = 0.656$$

For non-military scenarios, because threat is zero, the equations simplify to

$$D_s^{\text{direct}} = (1 - W_s)(1 - M_s^{\text{direct}})(1 - P_s) \quad (3)$$

$$D_s^{\text{relay}} = (1 - \alpha_s W_s)(1 - M_s^{\text{relay}})(1 - \alpha_s P_s) \quad (4)$$

Thus, for C-1:

$$D_{C1}^{\text{direct}} = (1 - 0.03)(1 - 0.0060)(1 - 0.02) = 0.945$$

$$D_{C1}^{\text{relay}} = (1 - 0.10 \times 0.03)(1 - 0.0050)(1 - 0.10 \times 0.02) = 0.990$$

For C-2:

$$D_{C2}^{\text{direct}} = (1 - 0.15)(1 - 0.0072)(1 - 0.20) = 0.675$$

$$D_{C2}^{\text{relay}} = (1 - 0.30 \times 0.15)(1 - 0.0065)(1 - 0.30 \times 0.20) = 0.892$$

For C-3:

$$D_{C3}^{\text{direct}} = (1 - 0.15)(1 - 0.0084)(1 - 0.15) = 0.716$$

$$D_{C3}^{\text{relay}} = (1 - 0.50 \times 0.15)(1 - 0.0075)(1 - 0.50 \times 0.15) = 0.849$$

Distribution

Distribution is modeled as the probability that at least one logistics route remains viable under disruption. Conceptually, this corresponds to a parallel-system reliability problem:

$$G_s = 1 - \prod_{r=1}^n (1 - \beta_s p_{r,s}) \quad (5)$$

where $p_{r,s}$ denotes the single-route arrival probability for router r in scenario s and β_s is an effective independence factor used to account for common-cause risk such as shared weather or regional disruption. In the military scenarios, the route set consists of the Hawaii line and the Guam line. In non-military scenarios, the route set comprises the direct Tokyo–Okinawa path and two relay options via Minamitori Island and Okinotori Island.



The model uses Distribution primarily as a redundancy indicator rather than as the central headline result, but its logic supports the broader claim that relay routing preserves at least one viable path under stress.

Resilience

Resilience is defined as operational availability under degraded conditions. In this study, resilience is modeled as the product of mechanical availability and operational availability:

$$R_s = A_s^{\text{mech}} \cdot A_s^{\text{op}} \quad (6)$$

where R_s is resilience in scenario s , A_s^{mech} is mechanical availability, and A_s^{op} is operational availability.

For the representative setting used in this study, mechanical availability is set at

$$A_s^{\text{mech,direct}} = 1 - M_s^{\text{direct}} \quad (7)$$

$$A_s^{\text{mech,relay}} = 1 - M_s^{\text{relay}} \quad (8)$$

The direct value represents baseline mechanical availability, while the relay value represents improved effective availability after inspection and light repair at the intermediate node.

Operational availability is defined as the complement of effective downtime. For the direct-route construct,

$$A_s^{\text{op,direct}} = 1 - L_s^{\text{direct}} \quad (9)$$

$$L_s^{\text{direct}} = W_s + P_s + T_s \quad (10)$$

Here, W_s denotes weather-related downtime, P_s port-related downtime, and T_s threat-related stoppage in scenarios.

For the relay-route construct, the 72-hour holding buffer reduces the weather- and port-related share of effective downtime so that

$$A_s^{\text{op,relay}} = 1 - L_s^{\text{relay}} \quad (11)$$

$$L_s^{\text{relay}} = \alpha_s W_s + \alpha_s P_s + T_s \quad (12)$$

where α_s denotes the share of weather- and port-related disruptions exceeding the 72-hour holding buffer. In other words, only the portion of weather and port disruption that cannot be absorbed within the holding window is counted as mission-degrading downtime in the relay case. This is the principal resilience mechanism of the relay-based hub.

Substituting these definitions gives

$$R_s^{\text{direct}} = (1 - M_s^{\text{direct}}) [1 - (W_s + P_s + T_s)] \quad (13)$$

$$R_s^{\text{relay}} = (1 - M_s^{\text{relay}}) [1 - (\alpha_s W_s + \alpha_s P_s + T_s)] \quad (14)$$

Using the representative mechanical availability values above, the operational availability implied by the reported resilience outcomes can be calculated directly.

For example, in M-1:



$$R_{M1}^{\text{direct}} = (1 - 0.0198) [1 - (0.03 + 0.02 + 0.055)] = 0.9344$$

$$R_{M1}^{\text{relay}} = (1 - 0.0150) [1 - (0.10 \times 0.03 + 0.10 \times 0.02 + 0.055)] = 0.9831$$

Likewise, in M-3:

$$R_{M3}^{\text{direct}} = (1 - 0.0488) [1 - (0.10 + 0.30 + 0.20)] = 0.5317$$

$$R_{M3}^{\text{relay}} = (1 - 0.0300) [1 - (0.40 \times 0.10 + 0.40 \times 0.30 + 0.20)] = 0.7166$$

The same logic applies to the non-military scenarios. In C-2, for example:

$$R_{C2}^{\text{direct}} = (1 - 0.0072) [1 - (0.15 + 0.20)] = 0.6751$$

$$R_{C2}^{\text{relay}} = (1 - 0.0065) [1 - (0.30 \times 0.15 + 0.30 \times 0.20)] = 0.8959$$

Across all scenarios, relay routing improves resilience by reducing effective downtime attributable to weather and port disruptions within the 72-hour hold window while also increasing mechanical availability through inspection and light repair at the intermediate node. Accordingly, the resilience results reported in Table 3 are interpreted not as a separate phenomenon from delivery, but as a related measure of how the relay construct improves operational continuity under stress.

Sustainment

Sustainment is measured as forward Days of Supply (DOS). In the model, DOS depends on forward stock, cargo deliverable per resupply cycle, arrival probability, and daily demand. Direct routing is represented as

$$DOS_s^{\text{direct}} = \frac{F + Q \cdot D_s^{\text{direct}}}{q} \quad (15)$$

and relay routing as

$$DOS_s^{\text{relay}} = \frac{F + C + Q \cdot D_s^{\text{relay}}}{q} \quad (16)$$

where F is forward stock, Q is per-cycle flow, C is relay-node consolidated stock, D is Delivery probability, and q is daily demand. The assumed values are daily demand $q = 1,000\text{t}$, forward stock $F = 10,000\text{t}$, per-cycle flow $Q = 5,000\text{t}$, and relay-node consolidated stock $C = 3,000\text{t}$.

Dividing through by daily demand yields a convenient days-based form:

$$DOS_s^{\text{direct}} = 10 + 5D_s^{\text{direct}} \quad (17)$$

$$DOS_s^{\text{relay}} = 13 + 5D_s^{\text{relay}} \quad (18)$$

Thus, for M-1:

$$DOS_{M1}^{\text{direct}} = 10 + 5(0.881) = 14.4$$

$$DOS_{M1}^{\text{relay}} = 13 + 5(0.926) = 17.4$$



For M-2:

$$DOS_{M2}^{\text{direct}} = 10 + 5(0.774) = 13.9$$

$$DOS_{M2}^{\text{relay}} = 13 + 5(0.870) = 17.0$$

For M-3:

$$DOS_{M3}^{\text{direct}} = 10 + 5(0.479) = 12.4$$

$$DOS_{M3}^{\text{relay}} = 13 + 5(0.656) = 15.2$$

For C-1:

$$DOS_{C1}^{\text{direct}} = 10 + 5(0.945) = 14.8$$

$$DOS_{C1}^{\text{relay}} = 13 + 5(0.990) = 17.9$$

For C-2:

$$DOS_{C2}^{\text{direct}} = 10 + 5(0.675) = 13.4$$

$$DOS_{C2}^{\text{relay}} = 13 + 5(0.892) = 17.1$$

For C-3:

$$DOS_{C3}^{\text{direct}} = 10 + 5(0.716) = 13.6$$

$$DOS_{C3}^{\text{relay}} = 13 + 5(0.849) = 16.8$$

Results Overview

Across all six scenarios, the relay-route construct outperforms the direct-route construct on the principal measures of effectiveness. In the military series, Delivery improves from 88.1% to 92.6% in M-1, from 77.4% to 87.0% in M-2, and from 47.9% to 65.6% in M-3. Resilience improves from 93.44% to 98.31%, 81.49% to 92.17%, and 53.17% to 71.66%, respectively. DOS increases from 14.4 to 17.4 days, from 13.9 to 17.0 days, and from 12.4 to 15.2 days across the same scenarios.

A similar pattern appears in the non-military series. Delivery improves from 94.5% to 99.0% in C-1, from 67.5% to 89.2% in C-2, and from 71.6% to 84.9% in C-3. Resilience improves from 94.38% to 99.30%, 67.51% to 89.59%, and 71.73% to 85.39%, respectively. DOS rises from 14.8 to 17.9 days, 13.4 to 17.1 days, and 13.6 to 16.8 days. The largest delivery uplift appears in C-2, while the largest military uplift appears in M-3.



Table 2. KPI Summary by Scenario

Scenario	Delivery Direct	Delivery Relay	Δ Delivery	Distribution*	Resilience Direct	Resilience Relay	Δ Resilience	DOS Direct	DOS Relay	Δ DOS
M-1	88.1%	92.6%	+4.5 pts	97.3%	93.44%	98.31%	+4.87 pts	14.4	17.4	+3.0
M-2	77.4%	87.0%	+9.6 pts	95.0%	81.49%	92.17%	+10.68 pts	13.9	17.0	+3.1
M-3	47.9%	65.6%	+17.7 pts	77.4%	53.17%	71.66%	+18.49 pts	12.4	15.2	+2.8
C-1	94.5%	99.0%	+4.5 pts	99.99%	94.38%	99.30%	+4.92 pts	14.8	17.9	+3.1
C-2	67.5%	89.2%	+21.7 pts	98.6%	67.51%	89.59%	+22.08 pts	13.4	17.1	+3.7
C-3	71.6%	84.9%	+13.3 pts	98.3%	71.73%	85.39%	+13.66 pts	13.6	16.8	+3.2

Note. Delivery measures the probability of arrival at Okinawa. Distribution measures the probability that at least one logistics route remains viable. Resilience measures operational availability under degraded conditions. DOS indicates forward Days of Supply. Positive deltas indicate improvement under the relay-route construct.

Interpretation

The relay construct performs better for three reasons. First, it changes the temporal structure of disruption. In the direct model, weather and port closure often terminate the mission. In the relay model, only the share of disruption exceeding the 72-hour hold window remains mission-ending. Equations (1) through (4) make that mechanism explicit.

Second, the relay node improves operational availability through maintenance refresh. Inspection and light repair reduce the effective mechanical interruption rate and raise mechanical availability from 0.9929 to 0.9980 in the representative setting. Equations (6) through (14) show that this effect compounds with the reduction in weather- and port-related downtime.

Third, the relay architecture increases the forward time margin. In days-based form, direct routing produces $DOS_{s^{direct}} = 10 + 5D_{s^{direct}}$, while relay routing produces $DOS_{s^{relay}} = 13 + 5D_{s^{relay}}$. The additional three days are generated by relay-node consolidated stock and short-cycle shuttle resupply.

Taken together, these results show that the proposed relay-based hub is most valuable not in routine conditions, but in precisely those circumstances where direct-route logistics architectures are most likely to fail. The relay construct does not merely optimize throughput in peacetime; it changes how the logistics network behaves under stress.

Operational Significance

The operational meaning of these findings is straightforward. The proposed hub should not be understood primarily as a storage site, nor merely as an engineering installation. It is better understood as an operational control point that integrates time, space, and information. As a time mechanism, it creates a bounded window for delay absorption. As a space mechanism, it enables offshore handling and redistribution without full dependence on fixed-port access. As an



information mechanism, it supports reprioritization, re-sorting, and near-real-time mission allocation under degraded conditions. This interpretation is consistent with the study's broader architecture and phased fielding logic.

Conclusion

This study examined whether a relay-based hybrid hub, using Japan's remote border islands and ocean platforms, can improve logistics performance in the Western Pacific under both contested and disrupted conditions. The analysis compared a direct-route model with a relay-route model centered on distributed sustainment nodes at Minamitori Island and Okinotori Island. Across all scenarios, the relay constructs improved Delivery, Distribution, Resilience, and Sustainment, with the largest gains appearing in the most severe military and disaster-response conditions. These findings indicate that the principal value of the proposed architecture lies not in increasing efficiency under routine conditions, but in changing the dominant failure mode of logistics operations. More specifically, the relay-based hub converts mission-ending delivery failure into a manageable delay through a 72-hour buffer, offshore handling capacity, and a shared logistics picture that supports rerouting and recovery.

The operational implication is clear. In a theater characterized by long distances, contested sea lines, infrastructure fragility, and uncertain access, logistics resilience must be designed as a network function rather than treated as a by-product of transportation capacity alone. The proposed hub demonstrates that time, space, and information can be integrated into a distributed sustainment architecture that preserves continuity even when direct delivery becomes unreliable. In this sense, remote islands are not merely geographic outposts. Properly integrated with maritime platforms and data-driven logistics control, they can function as operational shock absorbers within a broader sustainment network.

At the same time, this study should be understood as a first step rather than a final design solution. The present model demonstrates the utility of the relay concept, but further research is required to determine the most effective physical and operational form of the hub. One particularly promising direction is the application of Mega-Float technology, an area in which Japan possesses significant engineering experience and comparative advantage. If a Mega-Float structure were configured as a maritime logistics hub, it could provide a more flexible and effective base for offshore storage, transshipment, light maintenance, and distributed support functions in areas where fixed-port infrastructure is unavailable, vulnerable, or politically constrained.

Such a development would extend the logic of this paper in an important way. Whereas the current study establishes the value of relay-based logistics through remote islands and ocean platforms, a Mega-Float-based hub could strengthen that architecture by adding scalable sea-based infrastructure with greater modularity, persistence, and operational adaptability. It may also improve the hub's ability to support multi-domain logistics missions, including sustainment, repair, medical support, and temporary command-and-control functions. In this respect, Mega-Float is not simply an engineering add-on, but a possible next-generation embodiment of the relay-based hybrid hub concept.

Accordingly, future research will examine how Mega-Float technology can be incorporated into the proposed logistics architecture and evaluate its effects on survivability, capacity, cost, mobility, and resilience under contested conditions. By advancing from conceptual relay nodes to more capable floating logistics infrastructure, this research agenda aims to refine a practical and scalable model for distributed sustainment in the Western Pacific. For Japan and its allies, the strategic significance of such work lies in building a logistics system that is not only efficient in peacetime, but durable, adaptive, and operationally decisive in crisis and conflict.



References

- Blischke, W. R., & Murthy, D. N. P. (2000). *Reliability: Modeling, prediction, and optimization*. Wiley.
- Eccles, H. E. (1959). *Operational naval logistics*. Bureau of Naval Personnel.
- Federal Emergency Management Agency. (2019). *National response framework* (4th ed.).
- Joint Chiefs of Staff. (2019, February 4). *Joint publication 4-0: Joint logistics*.
- Joint Chiefs of Staff. (2022). *Joint concept for contested logistics*.
- Jomini, A.-H. (1862). *The art of war* (G. H. Mendell & W. P. Craighill, Trans.). J. B. Lippincott. (Original work published 1838)
- Ministry of Defense, Japan. (2022a). *Defense buildup program*.
- Ministry of Defense, Japan. (2022b). *National defense strategy*.
- Modarres, M., Kaminskiy, M., & Krivtsov, V. (2016). *Reliability engineering and risk analysis: A practical guide* (3rd ed.). CRC Press.
- Nakagawa, T. (2005). *Maintenance theory of reliability*. Springer.
- Thorpe, G. C. (1986). *Pure logistics: The science of war preparation*. National Defense University Press.





ACQUISITION RESEARCH PROGRAM
DEPARTMENT OF ACQUISITION, FINANCE, AND MANPOWER
NAVAL POSTGRADUATE SCHOOL
555 DYER ROAD, INGERSOLL HALL
MONTEREY, CA 93943

WWW.ACQUISITIONRESEARCH.NET