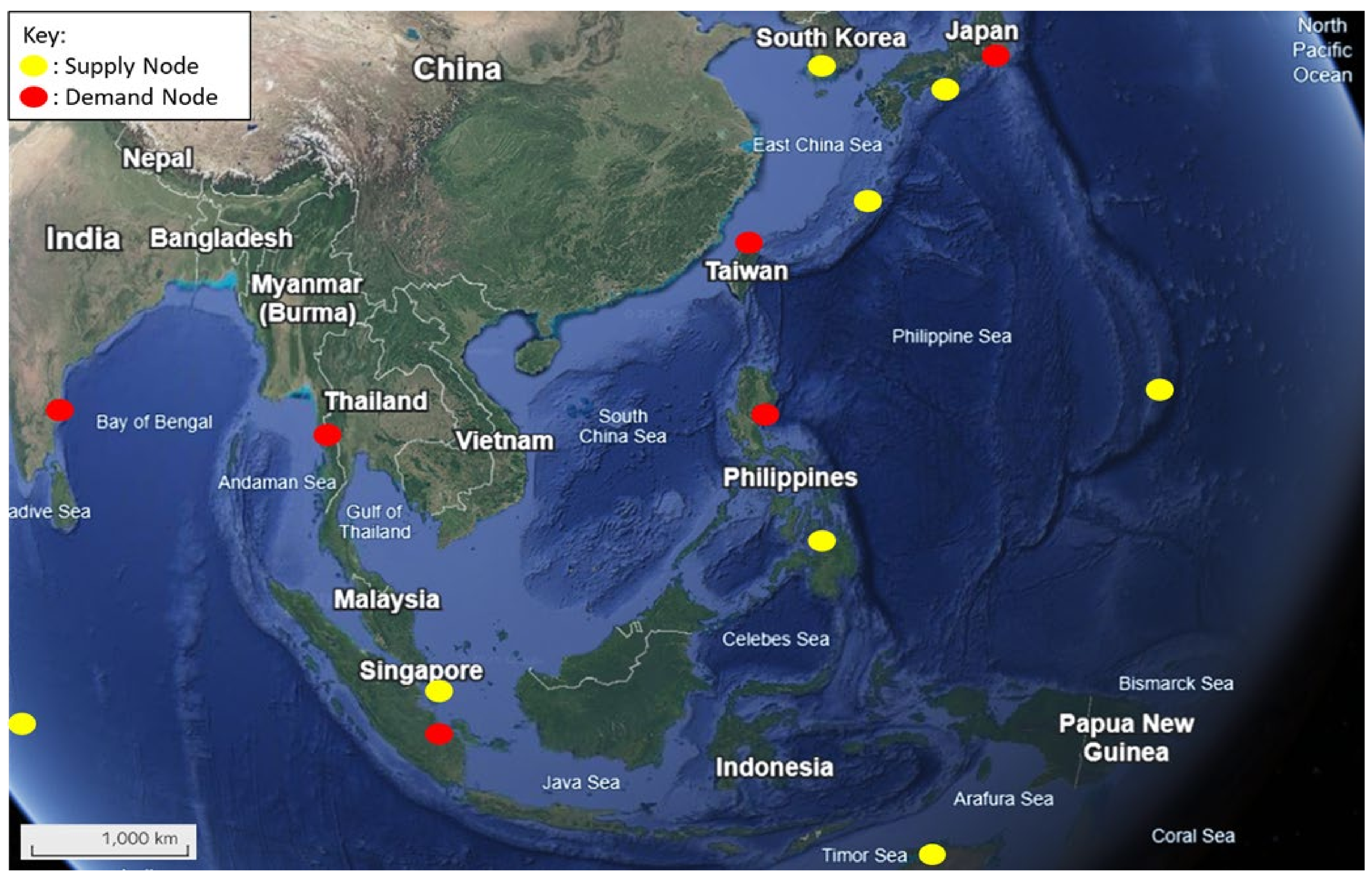
Forging the Logistics Coalition: Enhancing U.S. Marine Corps Disaster Response in the Indo-Pacific

NAVAL POSTGRADUATE SCHOOL

Overview

- The research centers around a network model focused on the distribution of five types of equipment (D & B TAMCN) from eight supply nodes (Okinawa, Yokota AB, Philippines, Guam, Singapore, Diego Garcia, Darwin, and South Korea) to six demand nodes (Philippines, Indonesia, India, Taiwan, Thailand, and Japan) for hypothetical HA/DR response scenarios.
- The purpose is to provide a paradigm for addressing HA/DR response, as it pertains to the USMC, in the strategically relevant and natural disaster-prone Indo-Pacific region. The model serves to make data-driven recommendations to establish an optimal prepositioning network.
- Research Question: What equipment, and how much, should be stored in which locations to minimize operational cost?



Methods

- Develop six network models, each aligned to a different demand node.
- Translate into six mathematical models dictated by an objective function to minimize operational cost as a function of distance between nodes & equipment weights/quantities.
- Compute in Microsoft Excel using linear programming techniques to optimize the allocation of resources.
- Conduct a time-space analysis of the results.

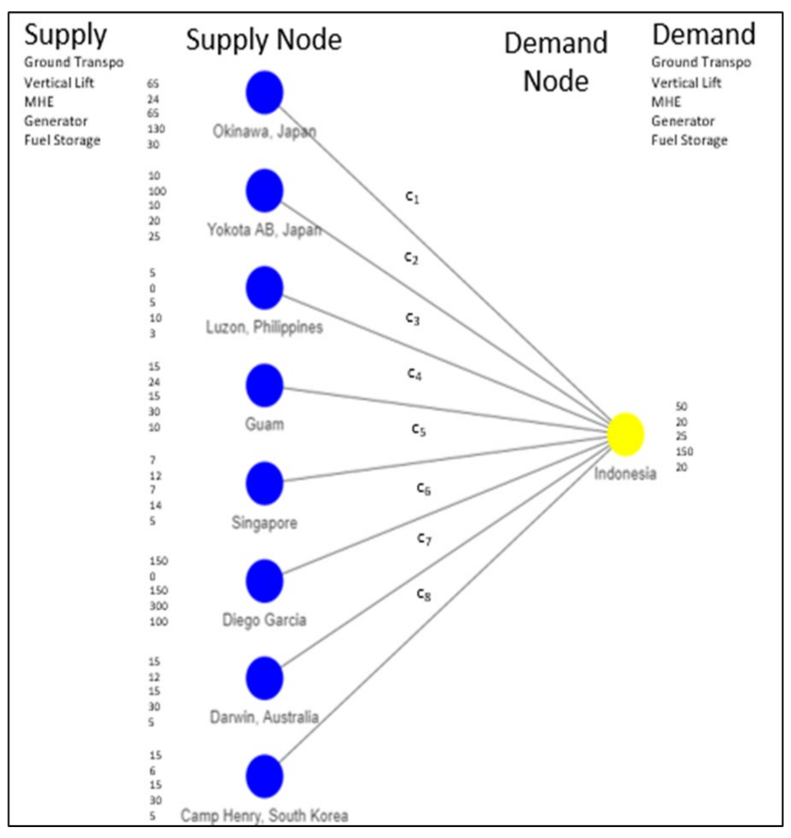


Figure 2. Network model for Indonesia response scenario

Indices
I = set of supply nodes [Okinawa, Yokota AB, Philippines, Guam, Singapore, Diego Garcia, Darwin, South Korea]

J = set of equipment types [ground transportation, vertical lift, MHE, generator, fuel storage]

Decision variables
X_{ij} = number of units of equipment j shipped from supply node i

Parameters
c_{ij} = cost to ship a piece of equipment j from supply node i
S_{ij} = supply at node i of equipment j
D_j = demand for equipment j

Objective Function
$$\underset{X}{\text{Minimize}} \sum_i \sum_j c_{ij} X_{ij}$$

Subject to
$X_{ij} <= S_{ij}$ (1)
$\sum X_{ij} >= D_j$ (2)
$(X_{i4}/6) - X_{i1} <= 0$ (3)
$(X_{i6}/2) - X_{i1} <= 0$ (4)
$X_{ij} >= 0$ for all i in I and all j in J (5)
X_{ij} is integer for all i in I and all j in J (6)

Figure 3. Mathematical model framework

Results & Recommendations

Figure 4. Supply nodes response matrix with response time considerations

Key:
- < 3 days, req
- > 3 days, req
- > 3 days, not req
- < 3 days, not req

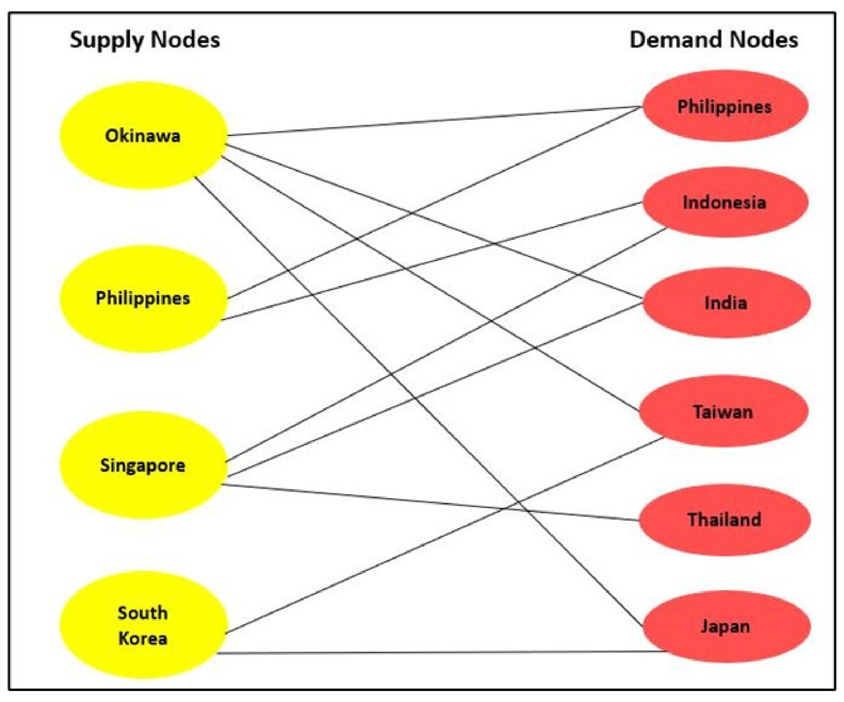


Figure 5. Simplified network model depicting the recommended logistics coalition based on model solutions

- Model solutions indicated that Okinawa, Singapore, and the Philippines were the most frequently utilized supply nodes due to their geographic positioning and equipment supply capacities. Diego Garcia, Yokota Air Base, South Korea, and Darwin served supporting roles, with variable usage depending on the scenario, while Guam was not used in any response.
- Reallocation of resources across supply nodes is recommended to form the most effective logistics coalition.
- This thesis offers a model framework that could serve as a foundation for a logistical planning decision tool for HA/DR responses.

- Data-based optimization models can aid in important logistics decisions.
- Models like the ones used in this thesis enable the adjustment of parameters (equipment, locations, etc.) to facilitate planning for other USMC operations, to include campaigning.

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