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A POLICY ANALYSIS FOR LOGISTICAL SUPPORT OF MULTIPLE U.S. ARMY CONTINGENCY REQUIREMENTS

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ABSTRACT

An analysis of policy options for management of logistical support of U.S. Army combat operations in limited conflicts (contingencies) is contained in this paper. Development and testing of a SLAM simulation model are discussed and a method of analyzing policy options presented. Results indicate that support can be enhanced through development of an improved priority system for supply allocation, development of supply centers in other than the United States, and through use of systematic diversion policies.

INTRODUCTION

In the event of limited war, the U.S. Army is charged with support of a number of different contingencies in various theaters of operations world-wide. Policies currently are in effect to provide logistical support for theater combat operations. These policies provide for prepositioned stocks in various parts of the world and for a reserve stockpile within the continential United States. As a conflict develops, the reserves are allocated based on need. Policy makers continually wrestle with the issue of stock apportionment, initial stock placement, and how the stocks would be allocated given the nature of the conflict. Also, the question of how multiple theater operations or contingencies would be managed must be answered.

The purpose of the research reported in this paper was development of a simulation model that could be used to address these issues. A model may be used to design a system that provides flexibility for responding to multiple operations and to study the effects of various policy options for managing combat logistical support (1).

Review of apportionment problems in World War II, Korea, and Vietnam provide several broad lessons that may be used in considering current problems and in developing a model. The first is the necessity for a "grand" strategy that provides for development guidelines for day-to-day decision making. The emphasis on the European theater in World War II is an example. The lack of this type of strategic objective caused a serious depletion of Army units in Europe and Korea during the Vietnam conflict. The place of Vietnam in a global strategy was not clear enough to logistics decision makers (7,8,10).

The second is the necessity for a "global" priority allocation system linked to the grand strategy. Even though there was a global strategy in World War II, there was not a clearly developed priority system based on the strategy (4). This caused short-term allocation decisions that placed significant stress on logistical support, and in some cases, caused protracted campaigns. A priority system also is necessary because enough resources simply do not exist to fully fund all "stated" requirements.

The third is the need to carefully integrate shipping assets into planning. Past conflicts show that transportation assets were inadequate to support originally devised operational objectives (7,10). An apportionment policy that does not consider transportation makes little sense. The capacity and use of a transport structure must be a part of apportionment schemes as well as of the planning for combat units. In the long-term, it may be wiser to allocate resources to transportation rather than direct combat capital.

The fourth is that the training base must not be depleted. Supplies must be given to units not yet committed to combat or their value when employed is reduced (4). The last lesson is that a fully developed logistics information system is critical. Any allocation scheme is dependent upon the accuracy and availability of information concerning asset status and requirements in each theater.

Design of a model and ultimately the allocation system will be based on these premises. In addition, a scenario that uses the following additional guidelines will be employed:

a. A commitment is made to support a hypothetical contingency (limited war) in some part of the world after which a second contingency that requires support develops.

b. Total support requirements exceed available resources.

c. Resources allocation must consider available transportation assets (8).

d. The strategy for allocating resources will place more importance on the second contingency.

e. A limited number of critical items will be studied. Given this, a more detailed look at system structure can be taken.

The remainder of the paper addresses system structure, model development, experimentation and policy development. The model has a combined network-discrete event orientation and is programmed in SLAM. A four-way, partial-factorial experimental design is used to test model results. Four policies with differing implications are discussed.

SYSTEM AND MODEL STRUCTURE

There are a number of structural features of the Army logistics system that impede its ability (or flexibility) to respond to competing demands, especially from different theaters. First, demands are filled on a first-come first-serve basis with the Uniform Material Movement and Issues Priority System. Urgency codes in multiple contingencies will be the same under this system. Second, only stocks within the Continental United States (CONUS) are immediately available for global dispersion. Third, the stocks are distributed among several management locations, none of which has global visibility.

To design flexibility into the system, several options are available. First, some apportionment policy based on a ranking scale may be used. The ranking scale should be based upon an analysis of the enemy's combat potential, the type of contingency being supported, the intensity and nature of the conflict, and the type of unit involved and its combat status. A second apportionment policy would allow visibility of global, not just CONUS stocks. A third apportionment policy would allow for "fencing" stocks. This option would involve allocation of critical items only to certain types of units.

In addition to these apportionment policies, a series of diversion options could be implemented. Diversion strategies are very difficult to implement because of the variation in the types of cargo that constitute aircraft (or other carrier) loads. A diversion policy will work only if limited and critical items are diverted, and only point-type diversions are allowed. This latter requirement means that only stocks transiting a given point would be diverted. To implement any diversion policy, the current Logistics Intelligence File would require modifications (2).

Implementation of any of the options is predicated on development of an information structure that allows visibility over the system. A general structure for an information system to support the concepts is shown in Figure 1. To test the structure shown, a combined discrete-event and network simulation model was developed. It was programmed in the Simulation Language for Alternative Modeling (SLAM)(5). A documented version is available from the authors on request.

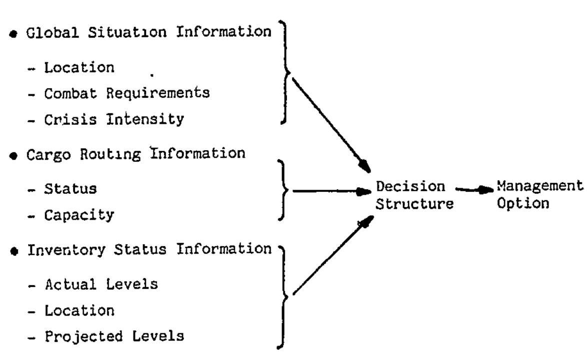

Figure 1. Information and Decision Structure

The model is constructed in five network modules supplemented with extensive FORTRAN inserts that are necessary to model the complex decision structures of the system. Module 1 contains code for demand generation, inventory status management, and for management of the other modules. Module 2 contains a structure for ranking competing demands, for allocating supplies and for managing transportation. The Module 3 network allocates supplies for demands not satisfied from CONUS stocks, and manages overseas transportation. Module 4 manages the diversion process and Module 5 contains the network structure for the transportation system.

The selection of a measure of effectiveness against which to compare alternative policies presents an interesting problem. A truly robust measure must consider the marginal contribution a given policy makes to combat potential. The measure does not have to assess directly combat power, because the priority system establishes the need for supplies. The experience and judgment of field commanders are used to establish need. The measure, therefore, can be simplified to consider only the volume of supplies delivered over time, if the assumption that the "right" supplies are moving is correct. The measure developed for the study was the total supply loads delivered divided by the total days to deliver. During the validation process for the model, it was accepted by executives as a viable measure.

The classical validation process of comparing model to system performance cannot be applied to such a model, because actual data based on combat experience were not available. In these type studies, Law and Kelton suggest a three-step approach consisting of (1) developing a model with high face validity, (2) empirically testing the assumptions of the model, and (3) determining the representativeness of results (3). A similar process has been suggested by the General Accounting Office for such models (9). The process was applied during model development and testing by involving experts responsible for planning and managing contingency operations. Most of the analysts and executives consulted were from the Army Material Development and Readiness Command (DARCOM) at Alexandria, Virginia.

The process began by assessing use of the triangular distribution to represent process and travel times. Experts provided estimates of the optimistic, modal and pessimistic values that could be expected to occur for given contingencies. This helped provide a strong basis for face validity and provided a means by which at least transportation processes could be tested under various configurations (sea, air ,land). The assumptions about system structure that were the basis for the model also were reviewed for reasonableness by DARCOM experts. They were adjusted to conform with current Army planning and policy. Modified Turing tests were used to assess the representativeness of output by having delivery ratios under different assumptions estimated by DARCOM analysts and comparing the estimates to model output. The two results agreed favorably.

Confidence that the model was adequate to meet the study objectives was sufficiently high enough to proceed with analysis. Use of the model to evaluate the various alternatives is discussed in the next section.

POLICY ANALYSIS AND CONCLUSIONS

The four design options of establishing clear demand priority, controlled release of on-hand inventory (fencing), establishing depots overseas (OCONUS), and diversion were tested using a full factorial design with the design matrix shown in Figure 2. As shown, this creates sixteen policies that could be implemented in the system. The significance of the main elements and their interactions were evaluated using a four-way analysis of variance.

Policy	Priority	Fencing	OCONUS	Diversion
1	1	1	1	1
2	1	1	1	-1
3	1	1	-1	1
4	1	1	-1	-1
5	1	-1	1	1
6	1	-1	1	-1
7	1	-1	-1	1
8	1	-1	-1	-1
9	-1	1	1	1
10	-1	1	1	-1
11	-1	1	-1	1
12	-1	1	-1	-1
13	-1	-1	1	1
14	-1	-1	1	-1
15	-1	-1	-1	1
16	-1	-1	-1	-1

Figure 2. Design Matrix

The results are shown in Figure 3. The three options of establishing a strong priority designation system, overseas depots, and diversion system are highly significant. Fencing was not. This is due to the type of scenario tested. For the test, the scenario was constructed so that the first combat erupted and ran for thirty days before the second contingency began. If a demand from the first contingency had a high priority but had not been filled when the second contingency erupted, it will be filled before too many demands from the second operation place stress on the system. If the system was, in fact, under severe stress, fencing may be attractive. Given the significance of the main effects, it is not surprising that the two, three, and four-way interactions show the results they do.

Main Effects				Probability Value
Priority (PRI)				.001*
Fencing (FEN)				.805
OCONUS (OCN)				.001*
Diversion (DIV)				.001*
Two-Way Interactions				
PRI	FEN			.861
PRI	OCN			.058*
PRI	DIV			.001*
FEN	OCN			.124
FEN	DIV			.912
OCN	DIV			.001*
Three-Way Interactions				
PRI	FEN	OCN		.250
PRI	FEN	DIV		.850
PRI	OCN	DIV		.001*
FEN	OCN	DIV		.375
Four-Way Interactions				
PRI	FEN	OCN	DIV	.672

* Significant at the α = .1 level

Figure 3. ANOVA Results

Given these results, a one-way analysis of variance was conducted to determine the "best" policy (combination of options) of the sixteen proposed. Sheffe' and Duncan multiple range comparison tests were conducted at the 0.05 level to discern between policies. Results indicated that no difference between the better policies of five, six, one and two existed. Since policy five achieved the highest pallets per day ratio of 7.4, an apparently effective means of managing the system is to allow overseas supplies to be available globally and to establish a priority system that insures demands are filled based on the existing level of combat intensity.

Since the model represents a system for which little data exists, extensive sensitivity analysis was performed for the four policies, model parameters, and possible scenarios. As expected, output is sensitive to changes in the range of the policies, parameter structure and scenario. Although specific results are available, they will not be discussed here (6). The value of the model in evaluating system design options was demonstrated in the process.

The research demonstrates that options for improving flexibility in logistics support of contingency operations are possible and attractive. Development of the model can be continued to enhance its ability to evaluate specific contingency plans and transportation structures. Adapting its use for evaluation of specific plans is recommended.

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