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EVALUATION OF THE PERFORMANCE OF THE COOPERATIVE LOGISTICS SUPPLY SUPPORT ARRANGEMENT FOR ROKAF

THESIS

Mansik Hur, Captain, ROK Air Force

AFIT/GAL/LAL/98S-5

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EVALUATION OF THE PERFORMANCE OF THE COOPERATIVE LOGISTICS SUPPLY SUPPORT ARRANGEMENT FOR ROKAF

THESIS

Presented to the Faculty of the Graduate School of Logistics

and Acquisition Management of the Air Force Institute of Technology

Air University

Air Education and Training Command

In Partial Fulfillment of the

Requirements for the Degree of

Master of Science in Logistics Management

Mansik Hur, Captain, ROK Air Force

September 1998

Approved for public release; distribution unlimited

Acknowledgments

I would like to thank my thesis advisor, Dr. Craig M. Brandt, and reader, Captain Marvin Arostegui for their help and guidance on my first research work. Special appreciation goes to Mr. Lavelle, the CLSSA manager at Air Force Security Assistance Center in WPAFB for his sincere explanations on questions and support in obtaining the requisition data base. Additionally, I appreciate all the teaching endeavor of the faculty members for their sincere education. I would like to thank the Republic of Korea Air Force for all the wonderful opportunities it has provided me. Finally, I send my deepest appreciation to my wife Jisoo for her help and understanding during our first overseas life at AFIT.

Mansik Hur

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Abstract

This thesis examines the performance of the Cooperative Logistics Supply Support Arrangement (CLSSA) for Republic of Korea Air Force (ROKAF). As one of the biggest FMS customer countries, ROKAF buys a substantial portion of its weapon systems from the U.S. Government and relies on the follow-on supply support from the source of acquisition. Because of the advantage of the CLSSA program for its timely support to foreign countries, the CLSSA has been the preferred method of follow-on supply support for FMS customer countries and its magnitude and coverage are being increased.

To find out the level of supply support for ROKAF, the programmed ratio of requisitions was summarized and the requisition fill times were analyzed statistically against key variables: programmed vs. non-programmed and priority of requisitions. The transportation time portion of the CLSSA program was also measured against different modes of shipment. For the statistical comparisons, one year's requisition data for 1996 were obtained from Air Force Security Assistance Center in AFMC, WPAFB OH. With the use of large sample z-tests, the statistical tests were performed; confidence intervals were constructed for the actual transportation times.

The test results showed that the programmed ratios of the CLSSA requisitions were increased significantly after the change in application of Stock Level Quantity and Eligible-to-be Programmed Quantity in 1994 over all FMS countries. Although the programmed requisitions were shown to be faster than non-programmed ones except for requisitions of high priority, the priority factor was not shown to play an expected role in

requisition filling process. The transportation time was observed to be moderate depending on the specified modes of shipment.

EVALUATION OF THE PERFORMANCE OF COOPERATIVE LOGISTICS SUPPLY SUPPORT ARRANGEMENT FOR ROK AIR FORCE

I. Introduction

Chapter overview

This chapter provides a background for the research topic of an evaluation of the performance of Cooperative Logistics Supply Support Arrangement (CLSSA) follow-on support for Republic of Korea Air Force (ROKAF). General issues of the research including historical overview on Foreign Military Sales (FMS), the research objective, the problem statement, and managerial implication is presented. Through related research, several approaches from different perspectives on the CLSSA are reviewed to help understand what the major concerns on this area were. Also, this chapter presents the scope and limitations of the research. Additionally, it provides definitions for basic concepts in the areas (FMS) and CLSSA.

General issues

Although one of the key issues of this thesis is supply support and its measure of performance, the context from which it derives should be reviewed above all to grasp the big stream that it belongs to. Even supply support of a small part from the United States

Department of Defense supply system, e.g., a requisitioning of a turbine blade of an aircraft engine, should be understood from the context of Security Assistance issue. Of course, the macro-level issue of this thesis is Security Assistance of the United States Government.

Security assistance

According to the Congressional Presentation Document, the objectives of Security Assistance are represented as following five categories:

> 1. Increasing the ability of United States security partners to deter and defend against aggression, and to shoulder more of the common defense burden.
>
> 2. Helping to maintain strong and cohesive defense arrangements with friends and allies, and to secure access to important military facilities throughout the world.
>
> 3. Promoting regional stability by arms transfer controls on the volume and types of weaponry provided to security assistance recipients.
>
> 4. Strengthening the economies of countries with which the United States has a security relationship and, when necessary, helping those governments toward market oriented economic policies.
>
> 5. Fostering human rights, democratic values and institutions.
>
> (Bae, 1998:9)

National security of allies and friendly nations has been strengthened through political and economical leverage of Security Assistance and Foreign Military Sales programs. Security Assistance has been and still remains an important instrument of U.S. foreign policy. Arms transfers and related services have reached enormous dimensions and involve most of the world's nations, either as a seller/provider or buyer/recipient (DISAM, 1997:41).

There are six major program components in Security Assistance as follows:

1. Foreign Military Sales (FMS) Program and Foreign Military Construction Sales (FMCS) Program.
2. The Foreign Military Financing Program (FMFP).
3. Direct Commercial Sales (DCS) Licensed under the AECA.
4. The International Military Education and Training (IMET).
5. The Economic Support Fund (ESF).
6. Peacekeeping Operation (PKO).

FMS has been one of the most dominant Security Assistance programs among the above in terms of international participation and political and financial activities. Also, it has been the major way for foreign nations to obtain major weapon systems and follow-on support. FMS is that portion of US security assistance authorized by the Arms Export Control Act (AECA), as amended, and conducted on the basis of formal contracts or agreements between the United States Government and an authorized recipient government or international organization. FMS includes government to government sale of defense articles or defense services, from DoD stocks or through purchase under DoD managed contracts, regardless of the source of financing.

As FMS is the largest program element in Security Assistance (SA) program of the United States Government, the CLSSA is the largest program component of FMS follow-on support. Evaluation of the performance of the largest component of the FMS program will show its role and importance in the area of FMS as well as Security Assistance.

Historical overview on FMS

Since the end of the Korean War, the United States has committed itself to the security of South Korea. In the 1954 U.S.-ROK Mutual Defense Treaty, the U.S. promised to help the Republic of Korea defend itself from external aggression.

This so-called 'blood-tied' relationship has been maintained between the two countries since that time. After the armistice agreement of 1953, the U.S. provided economic, administrational, and military assistance to Korea to keep the peace in the region. Assets and materials were provisioned to Korea to be used in the rebuilding of the nation and primary social welfare. Military equipment was also transferred to Korea for the re-construction of the ROK Armed Forces. These military assets were introduced to Korea under the Military Assistance Program (MAP) until the mid 1970s.

As Korea emerged as one of the world's largest economies with rapid economic growth, MAP was converted to FMS. Since then, the Foreign Military Sales program has been the ROK's major way of acquisition and procurement of military articles. Because of mutual interests, the continued North Korean threat, and the need for self-defense capability, the FMS expenditure has increased drastically. The table below depicts the magnitude of ROK's FMS transactions.

Table 1. ROK Foreign Military Sales Transaction Records

Unit: million $

YEAR	1987	1988	1989	1990	1991
AMOUNT	344	326	316	328	230
YEAR	1992	1993	1994	1995	1996
AMOUNT	309	306	374	431	393

Source: Foreign Military Sales Facts, 1996, DSAA.

U.S. policy on FMS

Presidential Decision Directive-34, signed on 12 February 1995 by President Clinton, outlines the United States policy on arms transfer:

> Transfers of conventional arms are legitimate instrument of U.S. foreign policy-deserving U.S. government support-when they enable us to help friends and allies deter aggression, promote regional stability, and increase interoperability of U.S. forces and allied forces. (Lumpe, 1995)

The goals of Presidential Decision Directive-34 are as follows:

> 1) To ensure that our military forces can continue to enjoy technological advantages over our potential adversaries.
> 2) To help allies defend themselves against aggression while promoting interoperability with U.S. forces when combined operations are required.
> 3) To promote regional stability in areas critical to U.S. interests, while preventing the proliferation of weapons intended for mass destruction as well as their missile delivery systems.
> 4) To promote peaceful conflict resolution and arms control, human rights, democratization, and other U.S. foreign policy objectives.
> 5) To enhance the ability of the U.S. defense industrial base to meet U.S. defense requirements and maintain long-term military technological superiority at lower costs.

Military weapon sales are legislated by the Foreign Assistance Act of 1961, as amended, and the Arms Export Control Act of 1976, as amended. The former provides the President with the legal authority to provide military assistance, financial and otherwise, to foreign nations. The latter authorizes him to sell weapons straight from the DoD inventory (Pineo and Lumpe, 1997). The Arms Export Control Act provides legal authority for Foreign Military Sales to strengthen U.S. security objectives and achieve mutual national defense requirements and objectives.

Managerial implication

All FMS customer countries usually have longer inventory pipelines than USAF due to longer physical distances and difficulties in in-transit visibility of assets. It has been inevitable for those countries to better manage the pipeline by trying to reduce pipeline time and increase inventory turn over. Because order and ship time can directly influence the performance of inventory management function, requisition fill time is considered to be the biggest leverage in effective and efficient management of follow-on logistics support. Although the CLSSA program does not guarantee that all eligible CLSSA requisitions will be filled immediately from depot stock, CLSSA requisitions are entitled to equal treatment with USAF requisitions within priority. Because CLSSA participant becomes a partner in the USAF and Defense Logistics Agency (DLA) supply systems, customer country can be provided with more timely follow-on supply support through reduced order and ship time. As an active participant and player in the logistics pipeline, it would be a good approach to figure out how CLSSA participant's spares requirement are forecast in advance, how support eligibility is decided, how financial liability and investment are defined on FMSO I case, and how efficient and effective the CLSSA performance is.

Research objective

Through this research, the supply responsiveness of CLSSA program will be evaluated by analyzing the CLSSA process. Along the total logistics pipeline, we see many sources of variability in processing time, which are represented by 'lead time'. This intermediate time can largely be classified by two factors: one is requisition fill time that

is under the control of U.S. source of supply, and the other is transportation time that is under the control of FMS country. Effective and efficient management of the FMS supply channel can be assured only when these two pipeline segments are controlled well and in balance.

When the performance of CLSSA supply support is evaluated, the first dimension to consider is the ratio of programmed requisitions to the total number of requisitions submitted during some specific time period. Since more timely support can be secured by stable management of demand rates, this ratio of programmed requisitions can measure how a FMS country has managed its CLSSA program by maintaining appropriate stock level quantities and reducing liabilities at Security Assistance Management Information System (SAMIS).

Supply responsiveness is measured mostly by requisition fill time distribution. Fill time distributions of 'programmed' and 'non-programmed' requisitions are expected to be significantly different: the former is expected to converge to narrow range of time periods, while the latter is expected to fluctuate with large variance. In reality, this is not the case at all times. By measuring the differences between two time distributions, the performance of the intended objective of participating CLSSA program can be evaluated.

After the supply responsiveness of CLSSA program is examined by analyzing the fill time distributions for both 'programmed' vs. 'non-programmed' requisitions, total logistics pipeline time will be measured from the receipt of requisition at SAMIS computer to the receipt of material at country's supply depot. From a customer's point of view, the variable of real concern is not only the requisition fill time at U.S. source of supply, but also the total logistics pipeline time. Because the pipeline segment of

transportation is another source of variance in service time, the level of CLSSA supply support felt by customers will be measured when the two components of variance are considered together.

Problem statements

This study determines the level of performance of CLSSA supply support for ROKAF by evaluating the supply responsiveness of CLSSA program. Also, it assesses the implementing procedure of the program by examining if the intended goal of participating in the CLSSA program is being satisfied by the customer country. Then, it incorporates the subsequent transportation segment of total logistics pipeline to diagnose the feasibility of movement control system of ROKAF as a part of FMS follow-on support. To answer the managerial question of what the level of supply responsiveness of CLSSA program is, the following specific questions will be answered as measurement questions.

Measurement question 1

What portion of CLSSA requisitions submitted during some specific period of time are processed as 'eligible-to-be programmed'?

Measurement question 2

What is the difference in mean fill time between 'programmed' and 'non-programmed' requisitions against different priorities and different types of items?

Measurement question 3

Is there a difference in mean fill time for 'programmed' requisitions against different priorities and different types of items? If so, how great is the difference for each case? And what could be the cause of the difference?

Measurement question 4

Is there difference in transportation time between requisitions of different priorities? What is the effect of the transportation segment of the supply pipeline on the total logistics pipeline time?

Related research

Pendley and Ratley. Pendley and Ratley evaluated the supply performance of the CLSSA program by comparing programmed and non-programmed requisition response time. After they examined FMS requisitions for USAF recoverable items and for NMCS requisitions, they concluded that programmed requisitions received no better treatment than non-programmed requisition. Their result indicated, however, requisition fill time for NMCS requisition was significantly improved for programmed requisition over non-programmed requisition. In some instances, the supply response time was not always consistent with the priority. The overall conclusion was that CLSSA is not, in reality, functioning according to the designed plan (Pendley, 1979:73-74).

To draw a statistical inference, they used only 60 NSNs as samples, which may be insufficient. In conducting a research on requisition fill time, they investigated the procurement lead-time of the item but did not include the quantity on the requisition as a possible intermediate variable.

Callahan, Johnson and Moradmand. CLSSA response time was also evaluated in the study of Callahan, Johnson and Moradmand in 1979. The response time was analyzed by comparing the fill times for the programmed and non-programmed requisitions. With the use of t-statistics, they found that mean fill times for programmed requisitions are statistically less than the fill time for comparable non-programmed

requisitions; a country's NMCS requisitions, however, do not appear to benefit significantly even if they are also coded as programmed. After they quantified the magnitude of the improved support, they attempted to determine through interviews with ILC personnel and Item Managers at various ALCs why AFLC logistics system was failing to provide a better level of support for programmed requisitions. But their research was limited only to those incomplete requisitions for which a supply date was available (Callahan, 1979: 76).

Silver. In 1986, Captain Silver, USAF, examined the accuracy of the requisition response time claims relative to CLSSA. To evaluate the response time effectiveness, he investigated if programmed requisitions have faster requisition response time than non-programmed requisitions. Furthermore, his study not only determined the differences in response time, but also examined the impacts of various factors that potentially influence requisition response time: (1) the type of item being requisitioned (either investment item or an expense items), (2) the requisition priority, and (3) the Air Logistics Center (ALC) supporting the requisitions (Silver, 1986:Ch 1, 2). With the use of chi-square and cumulative response rate method to evaluate data, he concluded that CLSSA appeared to be performing as expected on the whole.

Definition of terms

Definitions of terms used in this thesis on Security Assistance (SA) and Foreign Military Sales (FMS) are presented in a glossary at Appendix 1. Unless otherwise noted, all definitions were taken from the glossary of The Management of Security Assistance (17^{th} edition) published by The Defense Institute of Security Assistance Management.

Scope and limitations

The performance of FMS supply support can be ultimately evaluated by aircraft availability of customer country; it would be more authentic, precise, and understandable from the perspective of field activities. Completing the research outside of country makes it difficult to obtain applied inventory model and related data. Fortunately, the Air Force Security Assistance Center (AFSAC), the source of supply data is near the research institute in Air Force Material Command, Wright Patterson Air Force Base, OH. Therefore, the focus of research became concentrated on the performance of requisition fill time and related factors.

The customer order cycle includes all of the elapsed time from the placement of the order until the product is received and placed into the customer's inventory (Lambert and Stock: 515). To examine the supply responsiveness of CLSSA program, in this research, the requisition fill time is limited to the time from the receipt of requisition at Security Assistance Management Information System (SAMIS) computer to the delivery of material to the country assigned freight forwarder. The movement of material thereafter can be managed independently from above by choosing available and desired mode of shipment according to necessity and priority of the customer country. Transportation will be reviewed as an independent variable to the requisition fill time.

Sampling data that are used to measure the differences, if any, of requisition fill time under the CLSSA program are the actual ROKAF's data of completed requisitions of past period. Subsequent results are, therefore, applicable to ROKAF's inventory management area under CLSSA program.

II. Literature Review

Chapter overview

To help understand the basic FMS follow-on support, this chapter provides general concepts regarding FMS case, CLSSA backgrounds, Foreign Military Sales Order I (FMSO I), FMSO II, and requisitioning procedure. Computation methods for Stock Level Quantity (SLQ) and Eligible-to-be-programmed Quantity (EPQ) are presented as one of key variables that can determine the operational performance of CLSSA program. Another key variables "programmed" or "non-programmed" and priority issues are also presented to be used in statistical analysis of chapter III. After some considerations and features of CLSSA are addressed, recent changes on implementing procedures on CLSSA program will be presented. Finally, the necessity and initiatives of new CLSSA are presented followed by expected merits and some differentiated factors in new CLSSA.

FMS case

FMS customer countries are supported by an initial support package and by follow-on support cases for their management of a weapon system. Through the initial support package, a customer country establishes operating stocks that are used to maintain the weapon system. The initial support package usually includes the weapon system and the necessary support components (i.e., spares, support equipment, technical assistance, training, tools, and publication etc). Follow-on support is used to replenish

operating stocks as they are consumed to maintain the weapon system. As items become unserviceable through use, they may be repaired or replaced. This requires both repair and procurement actions, which initiate the beginning of the logistics support cycle.

There are three different types of FMS follow-on spare cases: Defined Order Case, Blanket Order Case, and Cooperative Logistics Supply Support Arrangement (CLSSA), all of which can be used for both repair and procurement (AFSAC, 1995: 1-1).

> A Defined Order case is one in which the defense articles, services, or training desired by the requesting country or international organization are specified/quantified by them in their Letter of Request, and subsequently stated explicitly in the Letter of Offer and Acceptance (LOA). The defined order case is most commonly used for sale of major end items, Significant Military Equipment (SME), and Major Defense Equipment (MDE).
>
> A Blanket Order case is an agreement between a customer and the United States Government to purchase a specific category of items or services (including training) at a set dollar value ceiling with no definitive listing of the exact items or quantities desired. Customers may requisition against a blanket order case as long as the case has funds available.
>
> A Cooperative Logistics Supply Support Arrangement (CLSSA) is a military logistics support arrangement designed to provide responsive follow-on support for United States produced military hardware possessed by foreign countries. Implementing Agencies may offer a CLSSA to a customer on approval form the Defense Security Assistance Agency (DSAA). (DISAM, 1997:209-212)

There are instances wherein one of the cases may be used, dependent upon implementing agencies and customer countries. Usually, standard items which are managed as U.S. DoD active inventory have been supported to foreign countries through CLSSA, while other items and parts which were obsolete or non-standard had been provided through D.O. and/or B.O. cases. One important distinction in both Defined Order and Blanket Order is that material requisitions are normally filled from DoD stocks only when on-hand assets are above the control level. Only through the CLSSA can FMS

requisitions be filled from below the control level. That is why CLSSA participation is recommended and preferred by FMS customer countries. Currently, more than 90% of ROKAF's expenditure on FMS follow-on support is disbursed through CLSSA.

Why CLSSA

> CLSSA is an agreement between the U.S. military service and a foreign military service or organization that sets forth the terms and conditions for providing more timely follow-on spares support. The CLSSA program can provide more timely follow-on support because the CLSSA participant becomes a partner in the USAF and Defense Logistics Agency (DLA) supply system. (AFSAC, 1995: 1-1)

As foreign countries become partners with the U.S. military, each country's spares requirements are forecast in advance. To do so, the CLSSA participant countries must invest in the USAF and DLA supply systems to allow the forecasted requirement to be bought in anticipation of future requisitions. The CLSSA participant's requisitions are then eligible to be filled from a combined pool of U.S. and CLSSA assets. The forecast and preliminary investments are the key features that differentiate the CLSSA from other types of FMS support cases. In return for this investment, CLSSA requisitions are entitled to support from depot stock equal to USAF requisitions within priority-the Force Activity Designator (FAD). More timely follow-on support is alleged by the implementing agency due to this differentiation. Though the former research of Pendley, et al. on CLSSA supply response time showed that the supply response time, in some instances, are not always consistent with the priority, the CLSSA has been the preferred and recommended method of follow-on support by many FMS customer countries.

Foreign Military Sales Order I (FMSO I)

A FMSO I case is called a stock level case because it defines the customer's follow-on spares requirement to be held on-hand or on-order by the USAF and DLA. It also provides the USAF and DLA the authority to buy and store material in anticipation of the CLSSA customer's requirements. It is then used to determine if the countries' requisitions are eligible to be filled from depot stock. Most importantly, it serves as the basis for the countries' financial investment in the U.S. supply system.

Table 2. FMSO I Eligible and Ineligible Item Category

FMSO I ELIGIBLE	FMSO I INELIGIBLE
• USAF managed investment items • USAF managed expense items • DLA managed expense items	• Non standard items • Part numbered items • Commercial consumable items • Support equipment • Other items that need special management or handling.

After FMSO I stock levels are established by the initial CLSSA program, they are to change based on a country's FMSO II case recurring requisitions. The stock levels are adjusted periodically to reflect the increase or decrease in a country's demand. Because not all customers may want to participate totally in CLSSA, various levels of participation are available. FMS customer may choose to participate, or to not participate in CLSSA. If participating, they can choose to participate for both "investment" and "expense" items, or just for either item. For investment (reparable) items, the FMS customer may choose to participate either for repair or procurement, or for both.

SAMIS FMSO I computations

A country's FMSO I requirements are forecasted based on demand history, that is a customer's recurring FMSO II demand. According to this demand history, SAMIS automatically computes a Stock Level Quantity (SLQ) and Eligible-to-be-programmed Quantity (EQP). The FMSO I SLQ is the customer's total FMSO I requirement and EPQ is the portion of the SLQ that can be used to code customer requisition as programmed by SAMIS (AFSAC, 1995:3-1). There is no transfer of material to the customer as a direct result of the FMSO I. FMSO I remains in existence as long as a country remains in CLSSA as a participant. Instead, it is adjusted as appropriate whenever changes on SLQ and EPQ are required due to the changes in country's withdrawal rate.

Stock Level Quantity (SLQ) computation. The FMSO I stock levels are calculated base on two factors: (1) the average FMSO II case recurring monthly demand and (2) the lead-time of the item. The formula is Average Monthly Demand (AMD) times the lead-time. It is important for a customer country, therefore, to be aware of the two variables to evaluate the effect that individual requisition will have on the FMSO I stock level quantity.

Eligible-to-be-Programmed Quantity (EPQ) computation. The EPQ is used by SAMIS in coding recurring FMSO II case investment item requisitions as programmed. Before July 1995, it was used to code FMSO II requisitions as programmed or non-programmed for expense items as well. Currently, a FMSO II

expense item requisition is coded as programmed as long as the item is FMSO I eligible and the demand is recurring. Therefore, the concern on the programmed ratio is actually applicable to only investment item requisitions. When a customer requisition is coded programmed, it becomes a candidate that can be filled from depot stock instead of entering into the procurement pipeline. The country-submitted eligible investment item requisitions are coded programmed if the requisition quantity is less than or equal to the EPQ.

Under the new CLSSA of 1994, there is no individual EPQ for each CLSSA participant country. Instead, there is just one worldwide repair EPQ and one worldwide procurement EPQ for each investment item NSN. This was one of the remarkable changes in CLSSA practices. Before 1994, EPQ was calculated for each CLSSA participant country according to the SLQ of the respective items. Under that circumstance, overall demands across the participant countries could not be satisfied collectively, although there existed sufficiency and deficiency for common items at the same time. To avoid that inefficiency, AFSAC combined the pool of demands across the all CLSSA countries. SLQ and EPQ are recomputed quarterly by SAMIS. SAMIS computes individual country EPQ amounts and then adds them together to determine the worldwide EPQ. This worldwide EPQ is not visible to the CLSSA customer countries. The only parameter a country can use as a guide when submitting requisitions is SLQ. So, it is important to ensure that individual requisition quantities be less than the customer's SLQ in order to maximize the number of requisitions coded programmed.

FMSO II requisitioning case

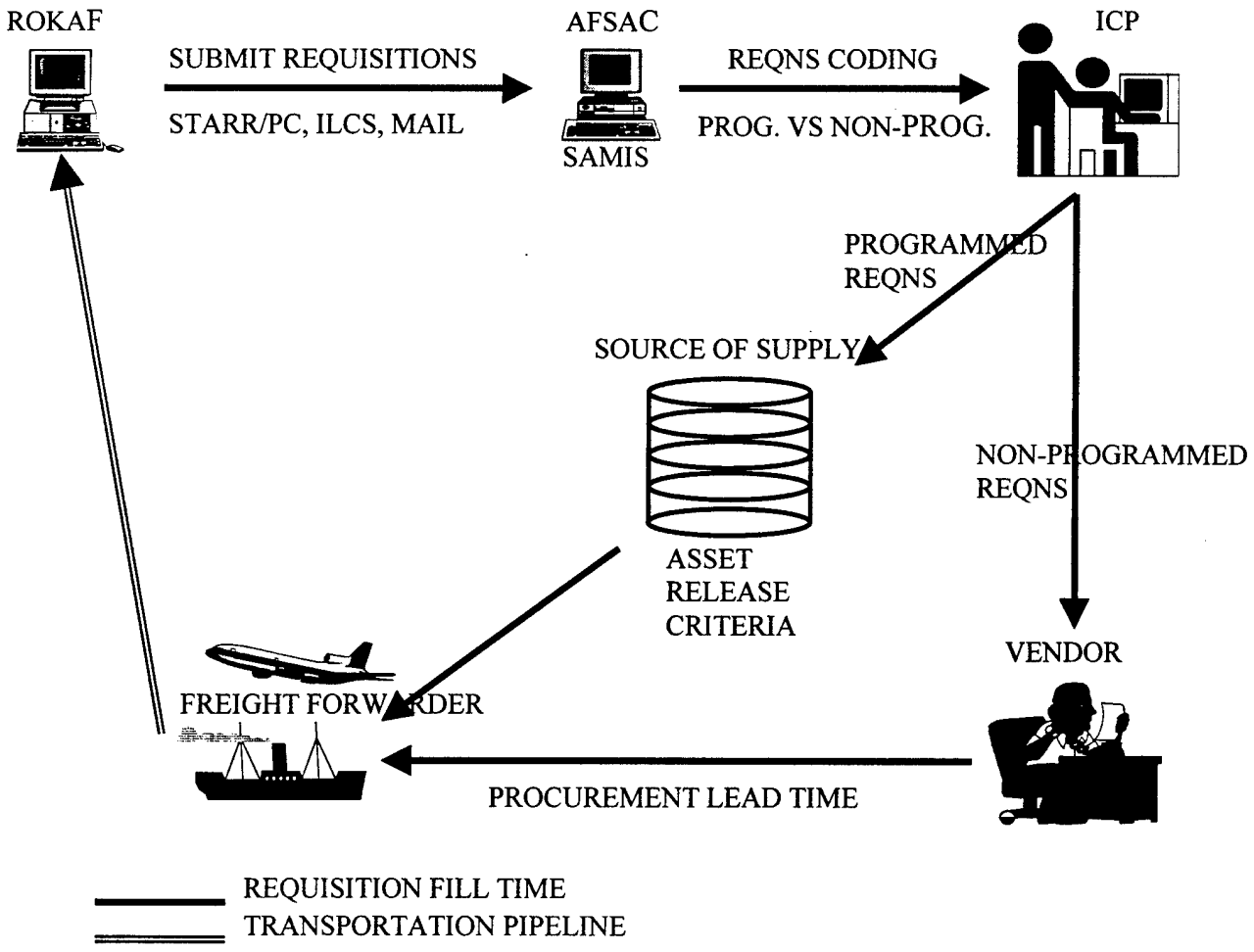
> The FMSO II is a case, which permits the country to requisition spares and repair parts for the replenishment of in-country stocks as they are consumed. The customer country's payments under the FMSO II case serve to replenish materiel withdrawn from DoD stocks and to maintain the country's level of equity investment in the U.S. DoD inventory. (DISAM, 1997:329)

A CLSSA participant country can submit requisitions on spares and repair parts. Both FMSO I and non FMSO I items may be requisitioned on the FMSO II case. Requisitions are submitted to SAMIS by available media such as International Logistics Communication System (ILCS), AUTODIN, STARR/PC, or mail. Each requisition routed to SAMIS must follow the standard format called Military Standard Requisition and Issue Procedure (MILSTRIP). MILSTRIP is the early form of Electronic Data Interchange (EDI) that has been utilized for supply transactions in U.S. military departments. Using MILSTRIP, necessary data on requisitions can be communicated i.e., recurring or non-recurring, priority of urgency need, and other supplemental information.

Requisition processing. Upon the receipt of the customer's FMSO II case requisition at SAMIS, the pipeline time for CLSSA supply responsiveness begins. After the requisition format is verified for accuracy, they are coded as "programmed" or "non-programmed" in accordance with the attribute of each item's category i.e., FMSO I eligibility, investment or expense item, recurring or non-recurring, and repair or procurement. Then requisitions are passed to appropriate Source of Supply (SOS). A SOS plays roles as inventory control point and supply and repair depot. Items are issued from depot stock or placed on order for procurement. The decision to issue from stock

depends on the number of assets available. The asset release criteria provides the rules on what level will be applicable for issue of item against each requisition.

It is important to recognize that recurring requisitions are recorded and reflected on the SAMIS demand history file for the purpose of the SLQ and the FMSO I case value for the country. In order for effective and efficient management of FMSO I case, a country should use demand code (recurring or non-recurring) prudently. Since the financial obligation over the excess quantity is reflected on liability file and/or termination file, a country should avoid peaked demand pattern, requisition with infrequent and large quantity. With a steady demand rate, there is more chance of being coded programmed for requisitions with small quantity within available EPQ.



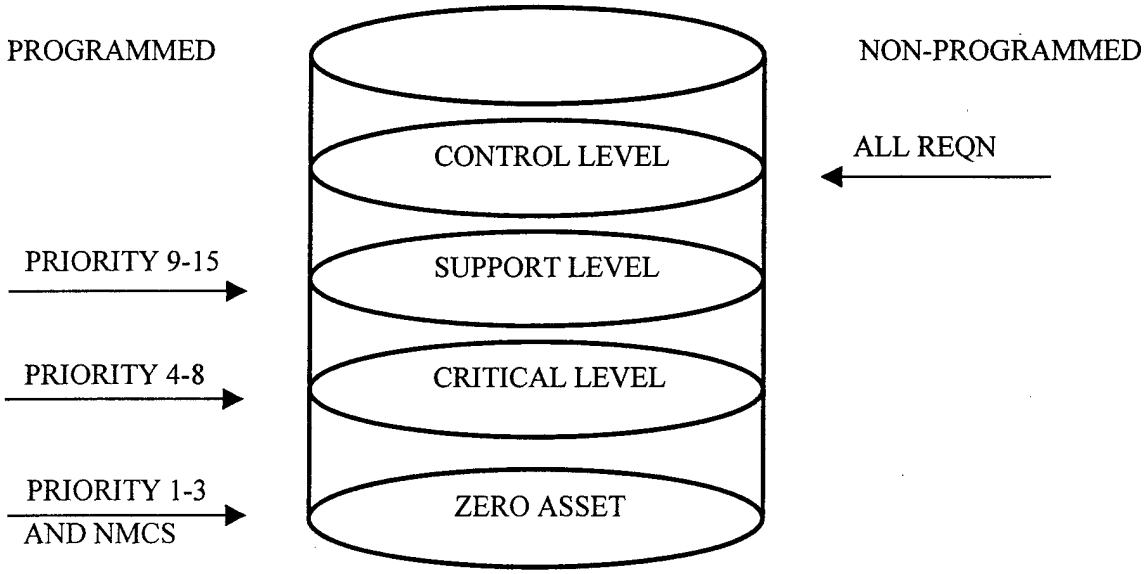


Figure 1. Requisitioning Process and Asset Release Criteria
(continued from page 19)

Transportation

Transportation is one of the six major logistics functions. According to Lambert and Stock, it is defined as the movement or flow of goods from point-of-origin to point-of-consumption-and perhaps their return as well. Transportation includes activities such as selecting shipment mode; choosing the specific path; and being aware of both domestic and international shipping requirements. Often transportation is the largest cost component in the logistics pipeline.

For FMS transportation, freight forwarders are used extensively. They consolidate numerous small shipments of various clients for the economies of scale. When transportation is involved in international shipping, forwarders provide administrational services, customs clearance, and temporary storage, especially for those

FMS customers with limited international shipping experience. According to the United State Government (USG) policy, FMS customers are responsible for the transportation activity. Detailed terms and conditions of transportation are specified by delivery term code on the Letter of Offer and Acceptance (LOA). Although the USG will furnish transportation services for items identified in the LOA to the point of delivery, most FMS customers are responsible for transportation from their country to the appropriate contractor. FMS customers are also responsible for the return of reparable items and from the CONUS Port of Embarkation (POE) to their country.

Once the items are issued from the source of supply, they are transported from the U.S. depot to country-assigned freight forwarder by commercial carrier. Thereafter, items are transported according to the priorities of the requisitions by freight forwarder. Of course, requisitions of high priority are scheduled for air and those of low priority are scheduled for sea.

III. Methodology

Chapter overview

This chapter presents the methodology used to evaluate the supply responsiveness of CLSSA program for ROKAF. Descriptive statistics and large sample z-test are used for the analyses of CLSSA pipeline time distributions. The variables of interest are described followed by explanation on the data collection method. Then, method for applied statistical analysis are presented.

Requisition fill time

One of the most important advantages in CLSSA, above all, can be characterized by its timely support instead of lead time away. The claimed timely support has been possible by financial investments of participant countries. However, it is not guaranteed for participant countries to always receive the timely support in spite of their ever-present investments.

As shown in related researches, the supply responsiveness is measured mostly by analysis of requisition fill time distributions. From a customer's perspective, requisition fill time can be total time elapsed from the submittal of requisition to the source of supply to the receipt of material at their supply depot. In order to measure the performance of the pipeline segment of CLSSA program that is under the control of the U.S. DoD system, the requisition fill time is defined as the total time from the receipt of requisition by the SAMIS computer to the shipment of material from the depot.

Variables of interest

The first thing to do in evaluating the supply responsiveness of the CLSSA program is to find out how many requisitions are being treated as programmed support, which means eligible to be filled from depot stock. Although the ultimate purpose of the CLSSA program is timely support to participant countries, there is one factor that causes a variance in the performance of the CLSSA program. That is, inherent variability is present in customer's demand rate. Because the SLQ and EPQ are computed based on the average of the past four-year's demand history, the probability of being programmed support also changes according to the demand history and pattern for items. Therefore, the first variable of interest will be the proportion of requisitions that are processed as programmed as desired.

After the programmed ratios are found, fill time distributions will be analyzed for both programmed and non-programmed requisitions against different priorities and different types of item (i.e., investment vs. expense item categories and procurement vs. repair). Obviously, the second variable of interest is the fill time distributions and differences among them.

And the third variable of interest will be the priority of requisitions. According to the combinations of Force Activity Designator (FAD) and Urgency Need Designator (UND), ROKAF assigns '03' for high priority requisitions which are usually for Not Mission Capable Supply (NMCS) and '06' and/or '13' for low priority requisitions which are usually for replenishment of operating inventory. Because CLSSA requisitions are entitled to equal treatments with USAF requisitions within priority and asset release criteria, high priority requisitions are expected to get faster supply support than low

priority requisitions. While priority does not matter on non-programmed requisitions, priority decides the level of support for programmed requisitions when material is to be issued, e.g., requisitions of priority "03" are to be supported until the zero balance of assets at source of supply. Comparison of fill times for programmed requisitions of each priority will diagnose if the priority of requisitions plays a role as expected.

Finally, transportation pipeline after the issue of material at source of supply will be examined. Because FMS customer countries are located far away from their major source of supply, the control of the transportation pipeline is essential to effective management of the total logistics pipeline. Due to the fact that longer ship time entails larger quantity of inventory requirement, there have been a lot of studies on the trade-off between shipping cost and inventory cost.

Potential difference in requisition fill time would be overshadowed if subsequent portion of total logistics pipeline were substantial. So, it will be added to requisition fill time to evaluate the magnitude of transportation segment on the performance of total logistics pipeline under CLSSA program. Subsequently, the last variable of interest is the mean transportation time of CLSSA requisitions.

Data collection

This thesis examines the supply responsiveness of CLSSA program for ROKAF. The population of interest is the total CLSSA requisitions submitted by ROKAF as an FMS follow-on support. To collect the requisition fill time data, the Security Assistance Management Information System (SAMIS), AFSAC's computer system is used. All the requisitions from customer countries are addressed to SAMIS, then each requisition is

coded as 'programmed' or 'non-programmed' according to its SLQ and/or EPQ. After each requisition is coded, it is sent to the appropriate Inventory Control Point (ICP). Finally, the requisition is filled from the source of supply according to asset release criteria and available inventory level.

In the course of filling requisitions, SAMIS handles and tracks related information. Its flexible and simple data base interrogation procedures allowed easy isolation and data collection for the specific population of interest. Requisition fill time can be collected based on several available selection criteria. For this research, requisition fill time will be collected into three categories to be compared with 'programmed' versus 'non-programmed'.

Table 3. Comparable Classification of Requisition Data Sets

MANAGEMENT CATEGORY	INVESTMENT ITEM PROCUREMENT
	INVESTMENT ITEM REPAIR
	EXPENSE ITEM PROCUREMENT
REQUISITION CODING	PROGRAMMED
	NON-PROGRAMMED
PRIORITY OF REQUISITION	HIGH (03)
	LOW (06 OR 13)

The whole population is obviously all of the requisitions submitted continuously by customer countries as follow-on support. To measure the concerned parameters on CLSSA program, one year's requisition data was selected as a sample. To preclude the effects of currently open requisitions, the sample data was selected for CY 1996. Although these requisitions data do not constitute the total population of ROKAF's

requisitions, they constitute a reasonable sample. Also, partial shipment data were excluded for the ease of analysis in this research. In order to perform statistical analyses about each variable of interest, requisition fill time data are broken out first by management category (investment vs. expense item), then by programmed vs. non-programmed, and by requisition priority (03 vs. 06 or lower).

Statistical test procedures

After the objectives and resulting measurement questions of interest are given, consideration must be given to the appropriate statistical tools to be applied. What are being compared in this study are observations of fill times for different kinds of requisitions under CLSSA program. The first variable of interest is what portion of ROKAF's requisitions are being processed as programmed.

When a study focuses on nominally scaled data, like 'programmed' or 'non-programmed', the variable of interest would be a population proportion parameter. And this population proportion is equal to the number of elements in the population belonging to the category of interest, divided by the total number of elements in the population. Proportion measures are necessary for nominal data and the most frequent concentration measure is the percentage (Cooper, 1995:204).

To measure the proportion of requisitions that received programmed support, total completed requisitions during the specified time period will be used. Because total actual data are available from the SAMIS database, there is no need to use any kinds of statistical test or related inference for population parameter. After the proportion is found

out, it will be compared with the average percentage of overall CLSSA participant countries' ratio to see the ROKAF's supply support efficiency.

The second variable of interest is the expected differences in fill time between programmed and non-programmed requisitions. To quantify these presumed differences, the following hypotheses will be tested for each set of comparable data sets.

$H_O: \mu_P - \mu_{NP} = 0$
$H_A: \mu_P - \mu_{NP} < 0$

Where, μ_P is the mean fill time for programmed requisition and,
μ_{NP} is the mean fill time for non-programmed requisition.

Then the objective is to make inferences about the differences in mean fill time of total requisitions submitted by ROKAF continuously. No assumptions need to be made about the probability distribution of the population, because the Central Limit Theorem assures for large samples that the test statistic will be approximately normally distributed regardless of the shape of the underlying probability distribution of the population. Therefore, the z-statistic is used with the following test statistics to make inferences about differences in mean fill time of population of requisitions.

$$z = \frac{(\bar{x}_1 - \bar{x}_2) - D_0}{\sqrt{\frac{\sigma_1^2}{n_1} + \frac{\sigma_2^2}{n_2}}}$$

Where, n_i is the sample size for sample i,
σ_i is the standard deviation for sample i,
$\bar{x}_i$ is the mean for sample i.

There are $2 \times 3 = 6$ pairs of comparable requisition data set, and they are as follows.

Table 4. Comparable Requisition Data Sets: Programmed vs. Non-programmed

	INVESTMENT ITEM REPAIR	INVESTMENT ITEM PROCUREMENT	EXPENSE ITEM PROCUREMENT
HIGH PRIORITY	(1)	(2)	(3)
LOW PRIORITY	(4)	(5)	(6)

In order to find out the effect of priority factor of requisitions, fill times of programmed requisitions will be compared against priorities within management categories. Again, the same z-test statistic will be used for the comparison.

The fourth variable of interest is to measure the transportation pipeline segment among total CLSSA logistics pipeline. In this study, relative time portion of transportation segment will be measured for each priority of requisition data set. There are two modes of shipment, which are employed by ROKAF: air and sea. The mode of shipment is determined by priority of requisitions. Of course, requisitions of high priority are scheduled for air transportation and those of low priority are by sea transportation.

The objective is to measure the portion of ship time of total CLSSA pipeline. For the analysis, requisition data will be broken out by their priorities: high for '03' and low for '06' or '13'. Within each priority of requisition data set, the mean portion of transportation time to total CLSSA logistics pipeline time will be assessed.

IV. Data Analysis

Data structure

The data generated from SAMIS consist of three management categories: investment item procurement, investment item repair, and expense item procurement from USAF ALCs and DLA supply centers. Table 5 shows the data format (requisition data for investment item procurement) which was used for statistical test in chapter III.

Table 5. Requisition Data Format (Investment Item Procurement)

FMS case	Document no.	P/NP	priority	SoS	DPS	XDS	XDF	Reqn. fill-time	Trans time
KSKCE	DKSH5V60071379	7	6	FPZ	96010	96122	96152	112	30
KSKCE	DKSH5V60071379	7	6	FPZ	96010	96195	96219	185	24
KSKCE	DKSH5V60071379	7	6	FPZ	96010	96202	96222	192	20
KSKCE	DKSH5V60080156	9	3	FGZ	96010	97244	97273	599	29
KSKCE	DKSH5V60080157	6	3	FPZ	96010	96104	96129	94	25
KSKCE	DKSH5V60080183	6	3	FHZ	96010	96220	96235	210	15
KSKCE	DKSH5V60081156	9	6	FGZ	96010	97241	97273	596	32
KSKCE	DKSH5V60081379	6	6	FHZ	96010	96011	96055	1	44
KSKCE	DKSH5V60081380	8	6	FHZ	96010	96011	96055	1	44
KSKCE	DKSH5V60081381	9	6	FHZ	96010	96011	96040	1	29

- DPS: date of requisition receipt at SAMIS.
- XDS: date of material shipment from SoS.
- XDF: date of material receipt at ROKAF supply depot.
- Reqn. Fill-time: days from DPS to XDS.
- Trans time: days from XDS to XDF.

The SAMIS data base consists of three different data files each representing different management categories. Each data file contains all the requisition data submitted by ROKAF from Jan. 1996 to Dec. 1996. Each record has all the data columns that are necessary for analysis of requisition fill time of the CLSSA program. The key data fields that are used to filter the variables of interest among all the requisition records

are 'programmed/ non-programmed' (P/NP) and 'priority' columns. The codes 3, 4, or 6 indicate programmed status and codes 7, 8, or 9 indicate non-programmed status. In case of priority, '03' represents high priority of requisition such as Not Mission Capable Supply (NMCS) while '06 and lower' represent low priority of requisition such as replenishment actions. The numeric codes made the manipulation of data easy on the statistical program.

Programmed ratio

The first variable of interest is the ratio of programmed requisitions among total requisitions submitted by ROKAF. To find out the general levels of programmed support, historical requisition data were requested to SAMIS additionally. The statistical requisition data obtained from SAMIS represent all the requisition data from Jan 1995 to Dec. 1997. Figure 2 shows the ratios of programmed requisitions against total submitted requisitions by ROKAF for each management category.

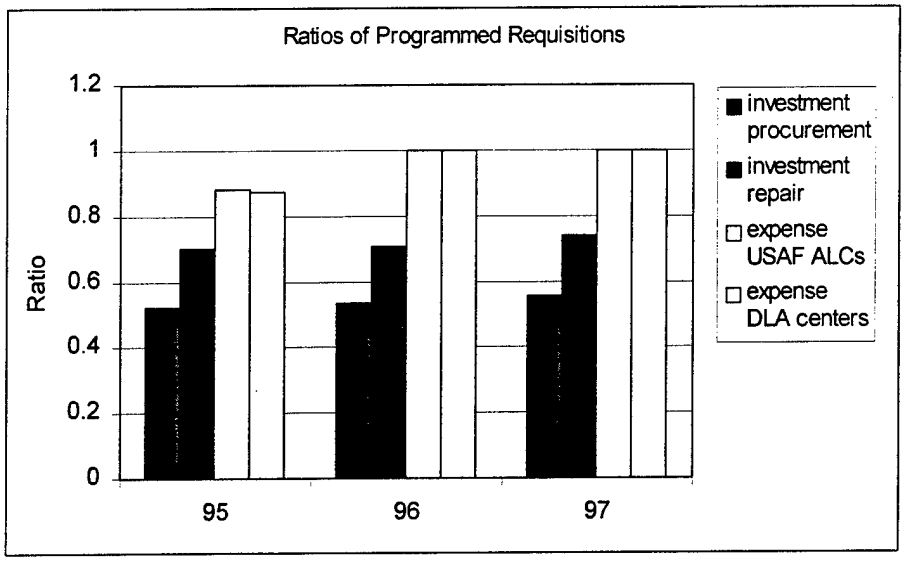


Figure 2. Ratios of Programmed Requisitions (CY 1995 - 1997)

Table 6. Status of Programmed Requisitions (1995 - 1997)

CATEGORY			1995	1996	1997
INVEST-MENT ITEM	PROCURE-MENT	PROGRAMMED	410	558	272
		TOT. REQNS	782	1046	490
	REPAIR	PROGRAMMED	2915	2452	2729
		TOT. REQNS	4155	3465	3678
EXPENSE ITEM	USAF ALC	PROGRAMMED	4928	5708	2597
		TOT. REQNS	5591	5708	2597
	DLA CENTERS	PROGRAMMED	32761	47133	38793
		TOT. REQNS	37552	47133	38793

In Figure 2, one can notice that the programmed ratio of "investment item repair" is always higher than that of "investment item procurement". Because there have been emphases on requisitions for investment item repair by customer countries, item managers at ALCs managed those requisitions especially. This pressure has been applied via the Quality Performance Indicators (QPI) that are reviewed by the ALC Commanders and the AFMC Commander (Lavelle, 1998). This also seems to be reflected on the fact that the repair lead-time is usually shorter (range from 6 to 10 months) than procurement lead time (range from 1 to 60 months).

In the case of expense items, the ratio of programmed requisition reaches almost 100% since 1996. Before October 1995, EPQ was applied both to investment and expense items. Requisitions for investment and expense items were coded 'programmed' or 'non-programmed' according to available EPQ at the time of requisition submittal. The policy was changed to apply EPQ only to investment items; consequently, all the requisitions of expense item were processed as programmed as long as they are recurring

and the items are established in FMSO I. Therefore, the variable of 'programmed ratio' should be considered only for investment items to which world wide EPQ is applied.

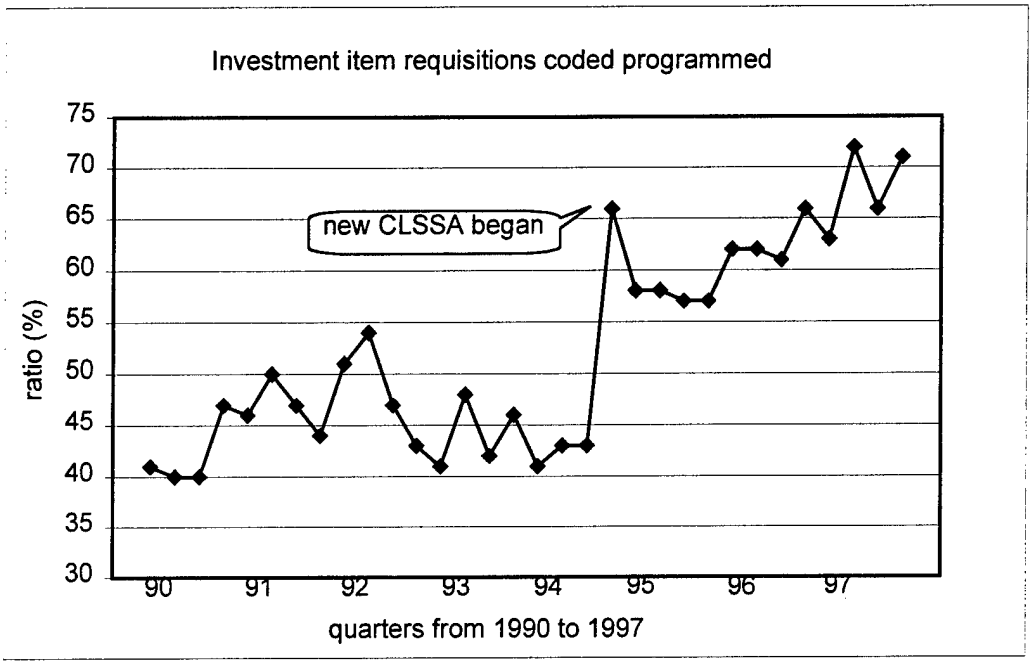


Figure 3. Programmed Ratios of Investment Item Requisitions (All countries)

Mentioned before, EPQ is applied only to investment items and it is computed based on the SLQ of each item for each country. Then, EPQs for each item of all countries are added up to make the world wide EPQ. Since EPQs are shared among all CLSSA participant countries, the probability of being programmed increased drastically. Figure 3 shows the 'level up' of the ratio of programmed requisitions for all countries after the change of EPQ application in October 1994.

Fill time comparisons

The second variable of interest is to measure the expected differences in fill time between programmed and non-programmed requisitions. To decide if the fill time of programmed requisitions is significantly faster than that of non-programmed requisitions, following hypotheses were tested for each pair of comparable data sets.

H_O: $\mu_P - \mu_{NP} = 0$
H_A: $\mu_P - \mu_{NP} < 0$

Where, μ_P is the mean fill time for programmed requisition and,
μ_{NP} is the mean fill time for non-programmed requisition.

In chapter 3 Methodology, 2 by 3 = 6 sets of data were considered to be compared. After the data base were obtained, I found that after the requisitions for investment item repair were submitted to SAMIS, priority of '03' was assigned to all of the requisitions in the course of coding requisitions, which made the original priority non-identifiable. Therefore, there are 5 sets of comparable requisition data, and they are as follows.

	INVESTMENT ITEM REPAIR	INVESTMENT ITEM PROCUREMENT	EXPENSE ITEM PROCUREMENT
HIGH PRIORITY	(1)	(2)	(4)
LOW PRIORITY		(3)	(5)

Test of hypotheses (z-test: two samples for means)

Table 7. Z-test: Investment Item Repair: Single Priority

	PROGRAMMED	NON-PROGRAMMED
MEAN FILL TIME IN DAYS	97.52238806	134.6411871
KNOWN VARIANCE	17327	23744
OBSERVATIONS	2613	1112
HYPOTHESIZED MEAN DIFFERENCE	0	
Z	-7.016849715	REJECTED
P(Z<=Z) ONE-TAIL	1.14209E-12	
Z CRITICAL ONE-TAIL	-1.644853	α=0.05

The first hypothesis addressed was a comparison of the mean fill times of requisitions for investment item repair between programmed and non-programmed ones. Analysis of the data provided the z-statistic of -7.017 which causes the null hypothesis to be rejected as the critical value for the z-statistic is z = -1.645, given a 0.05 level of significance (α = 0.05). This indicates that there is sufficient evidence to conclude that the mean fill time for programmed requisitions is significantly less than the fill time for non programmed requisitions. By comparing the mean fill time in days for two sets of requisitions, one can see that the mean fill time of programmed requisitions is much faster than that of non-programmed requisitions; variance of programmed requisitions is much smaller than that of non-programmed ones. In other words, the designed objective of CLSSA program is being met for requisitions of investment item repair.

Table 8. Z-test: Investment Item Procurement: High Priority

	PROGRAMMED	NON-PROGRAMMED
MEAN FILL TIME IN DAYS	164.4868	189.5888
KNOWN VARIANCE	39417	34936
OBSERVATIONS	76	107
HYPOTHESIZED MEAN DIFFERENCE	0	
Z	-0.86346	NOT REJECT
P(Z<=Z) ONE-TAIL	0.193943	
Z CRITICAL ONE-TAIL	-1.644853	α=0.05

The second hypothesis was a comparison of the mean fill times of high priority requisitions for investment item procurement between programmed and non-programmed ones. Analysis of the data provided the z-statistic of -0.863 which causes the null hypothesis not to be rejected as the critical value for the z-statistic is z = -1.645, given a 0.05 level of significance (α = 0.05). This indicates that there is not sufficient evidence to conclude that the mean fill time for programmed requisitions is significantly less than the fill time for non programmed requisitions. By comparing the mean fill time in days for two sets of requisitions, one can see that the mean fill time of programmed requisitions is faster by small amount than that of non-programmed requisitions; but it is not enough to be significant due to the large variances of two samples. In other words, the designed objective of CLSSA program is not being met for high priority requisitions of investment item procurement.

Table 9. Z-test: Investment Item Procurement: Low Priority

	PROGRAMMED	NON-PROGRAMMED
MEAN FILL TIME IN DAYS	107.2294	178.8898
KNOWN VARIANCE	23510	43347
OBSERVATIONS	497	944
HYPOTHESIZED MEAN DIFFERENCE	0	
Z	-7.42198	REJECT
P(Z<=Z) ONE-TAIL	5.82E-14	
Z CRITICAL ONE-TAIL	-1.644853	α=0.05

The third hypothesis was a comparison of the mean fill times of low priority requisitions for investment item procurement between programmed and non-programmed ones. Analysis of the data provided the z-statistic of -7.421 which causes the null hypothesis to be rejected as the critical value for the z-statistic is z = -1.645, given a 0.05 level of significance (α = 0.05). This indicates that there is sufficient evidence to conclude that the mean fill time for programmed requisitions is significantly less than the fill time for non programmed requisitions. By comparing the mean fill time in days for two sets of requisitions, one can see that the mean fill time of programmed requisitions is much faster than that of non-programmed requisitions; variance of programmed requisitions is much smaller than that of non-programmed ones. In other words, the designed objective of CLSSA program is also being met for low priority requisitions of investment item procurement.

Table 10. Z-test: Expense Item Procurement: High Priority

	PROGRAMMED	NON-PROGRAMMED
MEAN FILL TIME IN DAYS	104.9331	85.64167
KNOWN VARIANCE	27029	18174
OBSERVATIONS	912	120
HYPOTHESIZED MEAN DIFFERENCE	0	
Z	1.433577	NOT REJECTED
P(Z<=Z) ONE-TAIL	0.075847	
Z CRITICAL ONE-TAIL	-1.644853	α=0.05

The fourth hypothesis addressed was a comparison of the mean fill times of high priority requisitions for expense item procurement between programmed and non-programmed ones. Analysis of the data provided the z-statistic of 1.434 which causes the null hypothesis not to be rejected as the critical value for the z-statistic is z = -1.645, given a 0.05 level of significance (α = 0.05). This indicates that there is not sufficient evidence to conclude that the mean fill time for programmed requisitions is significantly less than the fill time for non programmed requisitions. By comparing the mean fill time in days for two sets of requisitions, one can see that the mean fill time of programmed requisitions is rather slower than that of non-programmed requisitions; variance of programmed requisitions is much larger too than that of non-programmed ones. In this case, programmed requisitions do not appear to have any advantage over non-programmed requisitions. In other words, the designed objective of CLSSA program is not being met for high priority requisitions of expense item procurement.

Table 11. Z-test: Expense Item Procurement: Low Priority

	PROGRAMMED	NON-PROGRAMMED
MEAN FILL TIME IN DAYS	31.81988	56.2186
KNOWN VARIANCE	8268	12656
OBSERVATIONS	53769	9547
HYPOTHESIZED MEAN DIFFERENCE	0	
Z	-20.0596	REJECTED
P(Z<=Z) ONE-TAIL	0	
Z CRITICAL ONE-TAIL	-1.644853	α=0.05

The last hypothesis was a comparison of the mean fill times of low priority requisitions for expense item procurement between programmed and non-programmed ones. Analysis of the data provided the z-statistic of -20.06 which causes the null hypothesis to be rejected as the critical value for the z-statistic is z = -1.645, given a 0.05 level of significance (α = 0.05). This indicates that there is sufficient evidence to conclude that the mean fill time for programmed requisitions is significantly less than the fill time for non programmed requisitions. By comparing the mean fill time in days for two set of requisitions, one can see that the mean fill time of programmed requisitions is much faster than that of non-programmed requisitions; variance of programmed requisitions is much smaller than that of non-programmed ones. In other words, the designed objective of CLSSA program is being met for low priority requisitions of expense item procurement.

Priority test

The comparisons of fill time between programmed and non-programmed requisitions indicated that fill time of programmed requisitions are not always faster than that of non-programmed requisitions. As indicated in the results of test statistics, the requisition fill time of programmed requisitions are shown faster than non-programmed ones as expected only for the requisitions of investment item repair (single priority), investment item procurement of low priority and expense item procurement of low priority. To see if requisitions of high priority have faster mean fill times and it makes the differences not detectable, another test of hypotheses were conducted.

H_O: $\mu_H - \mu_L = 0$
H_A: $\mu_H - \mu_L < 0$

Where, μ_H is the mean fill time for high priority requisition and,
μ_L is the mean fill time for low priority requisition.

To identify the possible effect of the priority factor, requisition fill times are compared between high and low priority within each management category. Therefore, there are 4 sets of comparable requisition data, and they are as follows:

	PROGRAMMED	NON-PROGRAMMED
INVESTMENT ITEM PROCUREMENT	(1)	(2)
EXPENSE ITEM PROCUREMENT	(3)	(4)

Table 12. Z-test: Investment Item Procurement - Programmed Requisitions

	HIGH PRIORITY	LOW PRIORITY
MEAN FILL TIME IN DAYS	164.4868	107.2294
KNOWN VARIANCE	39417	23510
OBSERVATIONS	76	497
HYPOTHESIZED MEAN DIFFERENCE	0	
Z	**2.40682**	NOT REJECT
P(Z<=Z) ONE-TAIL	0.008046	
Z CRITICAL ONE-TAIL	-1.644853	α=0.05

The first hypothesis was a comparison of the mean fill times of programmed requisitions for investment item procurement between high priority and low priority. Analysis of the data provided the z-statistic of 2.407 which causes the null hypothesis not to be rejected as the critical value for the z-statistic is $z = -1.645$, given a 0.05 level of significance ($\alpha = 0.05$). This indicates that there is not sufficient evidence to conclude that the fill time of high priority requisition is significantly faster than that of low priority requisitions. By comparing the mean fill time in days for two sets of requisitions, one can see that the mean fill time of high priority requisitions is slower than that of low priority requisitions; variance of high priority requisitions is larger than that of low priority ones. In other words, the expected advantage of high priority is not being observed for programmed requisitions of investment item procurement.

Table 13. Z-test: Investment Item Procurement - Non-Programmed Requisitions

	HIGH PRIORITY	LOW PRIORITY
MEAN FILL TIME IN DAYS	189.5888	178.8898
KNOWN VARIANCE	34936	43347
OBSERVATIONS	107	944
HYPOTHESIZED MEAN DIFFERENCE	0	
Z	**0.5544**	NOT REJECT
P(Z<=Z) ONE-TAIL	0.289653	
Z CRITICAL ONE-TAIL	-1.644853	α=0.05

The second hypothesis was a comparison of the mean fill times of non-programmed requisitions for investment item procurement between high priority and low priority. Analysis of the data provided the z-statistic of 0.554 which causes the null hypothesis not to be rejected as the critical value for the z-statistic is z = -1.645, given a 0.05 level of significance ($\alpha = 0.05$). This indicates that there is not sufficient evidence to conclude that the fill time of high priority requisition is significantly faster than that of low priority requisitions. By comparing the mean fill time in days for two sets of requisitions, one can see that the mean fill time of high priority requisitions is slower by little amount than that of low priority. In other words, the expected advantage of high priority is not being observed for non-programmed requisitions of investment item procurement, either.

Table 14. Z-test: Expense Item Procurement - Programmed Requisitions

	HIGH PRIORITY	LOW PRIORITY
MEAN FILL TIME IN DAYS	104.9331	31.81988
KNOWN VARIANCE	27029	8268
OBSERVATIONS	912	53769
HYPOTHESIZED MEAN DIFFERENCE	0	
Z	**13.39537**	NOT REJECT
P(Z<=Z) ONE-TAIL	0	
Z CRITICAL ONE-TAIL	-1.644853	α=0.05

The third hypothesis was a comparison of the mean fill times of programmed requisitions for expense item procurement between high priority and low priority. Analysis of the data provided the z-statistic of 13.395 which causes the null hypothesis not to be rejected as the critical value for the z-statistic is z = -1.645, given a 0.05 level of significance (α = 0.05). This indicates that there is not sufficient evidence to conclude that the fill time of high priority requisition is significantly faster than that of low priority requisitions. By comparing the mean fill time in days for two sets of requisitions, one can see that the mean fill time of high priority requisitions is much slower than that of low priority requisitions; variance of high priority requisitions is much larger than that of low priority ones. In other words, the expected advantage of high priority is not being observed at all for programmed requisitions of expense item procurement, either.

Table 15. Z-test: Expense Item Procurement - Non-Programmed Requisitions

	HIGH PRIORITY	LOW PRIORITY
MEAN FILL TIME IN DAYS	85.64167	56.2186
KNOWN VARIANCE	18174	12656
OBSERVATIONS	120	9547
HYPOTHESIZED MEAN DIFFERENCE	0	
Z	**2.38046**	NOT REJECT
P(Z<=Z) ONE-TAIL	0.008646	
Z CRITICAL ONE-TAIL	-1.644853	α=0.05

The fourth hypothesis was a comparison of the mean fill times of non-programmed requisitions for expense item procurement between high priority and low priority. Analysis of the data provided the z-statistic of 2.380 which causes the null hypothesis not to be rejected as the critical value for the z-statistic is $z = -1.645$, given a 0.05 level of significance ($\alpha = 0.05$). This indicates that there is not sufficient evidence to conclude that the fill time of high priority requisition is significantly faster than that of low priority requisitions. One can see that the mean fill time of high priority requisitions is slower than that of low priority requisitions; variance of high priority requisitions is larger than that of low priority ones. In other words, the expected advantage of high priority is not being observed for non-programmed requisitions of expense item procurement, either.

Transportation time

The fourth variable of interest is to measure the transportation pipeline segment of total CLSSA logistics pipeline. Transportation time is defined as the time from the issue of material at U.S. Sources of Supply (SoS) to the receipt of material at ROKAF's supply depot.

Total transportation time consists of 3 components which are designated as XDI, XDS, and XDF time. The codes are used by electronic material tracking system by customer country and freight forwarders. XDI is the time between issue of material at U.S. SoS and receipt of them by freight forwarder. This movement of assets is done by commercial carriers. XDS is the waiting time at freight forwarder's warehouse that is necessary for the consolidation of freights by freight forwarder. XDF is the transportation time from shipment by freight forwarder to the receipt by country depot. In this study, transportation time portion of total pipeline is measured for each priority of requisition data set. So, XDS, XDI, and XDF time are not identified respectively, but they are merged into one component of transportation time here. Mean fill times and mean transportation times are summarized in Table 16.

Table 16. Relative Portion of Transportation Time

Unit: in days

	PRIOR.	MEAN FILL TIME	TRANSPORTATION		MEAN TOTAL PIPELINE TIME
			MEAN TIME	%	
INVESTMENT REPAIR	N/A	108.6032	44.4596	29%	153.0628
INVESTMENT PROCUREMENT	HIGH	179.1639	34.0437	16%	213.2077
	LOW	154.1742	45.8383	23%	200.0125
EXPENSE PROCUREMENT	HIGH	96.2924	24.5233	20%	120.8158
	LOW	45.1329	48.4372	52%	93.5702

The comparison of transportation time between different priorities shows that the transportation time of high priority requisitions are shorter than that of low priority requisitions; its time portion is also smaller as expected.

Figure 4 shows the 95 % confidence intervals of transportation time for each management category. There is no overlapping interval between times of different priorities (between B and C; between D and E). Therefore, it can be said that transportation time of high priority requisitions is always faster than that of low priority requisitions.

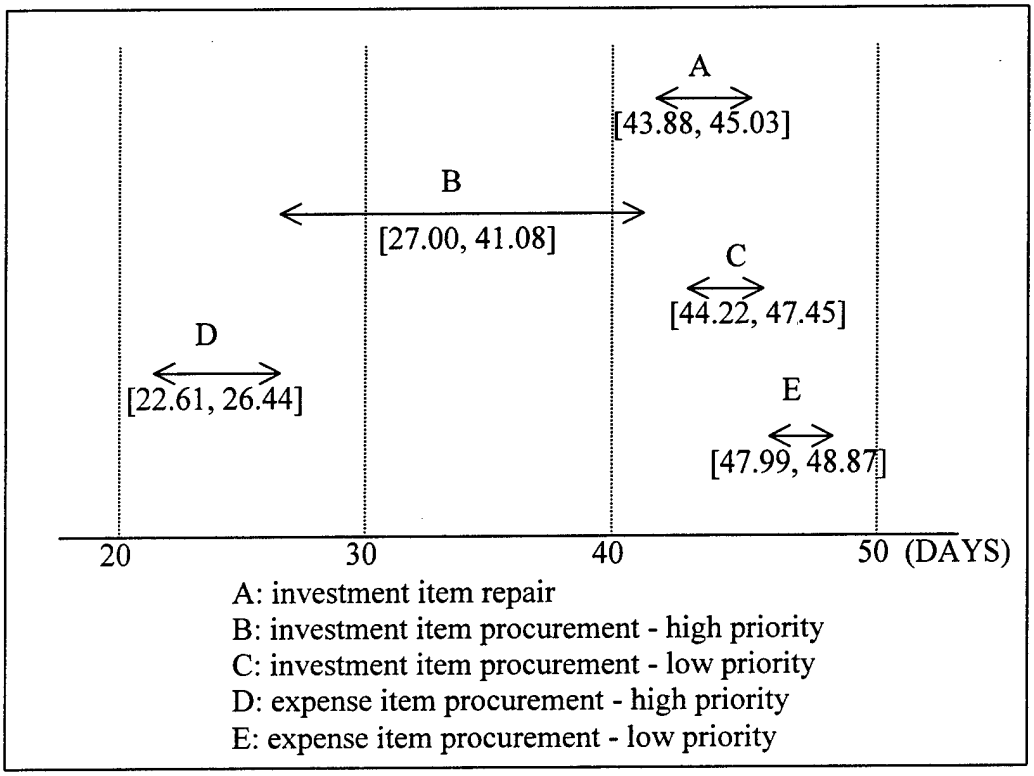


Figure 4. Confidence Intervals of Transportation Time

V. Conclusion

Chapter overview

This chapter presents the conclusion based on the results of data analyses. The managerial question of this research is the performance level of CLSSA supply support to ROKAF. The research variables examined to determine the level in previous chapters were the ratio of programmed requisitions of each management category, the actual advantage of programmed support, the role of priority of each requisition, and the magnitude of the transportation pipeline segment. The results are reviewed and interpreted in terms of managerial implication. Recommendation on the efficient management of CLSSA program is provided.

Programmed ratio

As alleged by implementing agencies of the CLSSA, one of the biggest advantages of the CLSSA program is its timely support for programmed requisitions. Even though "programmed support" does not always mean prompt supply support, customer countries have tried to increase the ratio of programmed requisitions, because there is higher probability of getting faster support. The data analyses show that programmed ratio of expense item reaches almost 100% after 1995, because EPQ was not applicable thereafter. In the case of investment items, the ratio of programmed for

"repair" is shown to be always higher than that of "procurement", which reflects the high interests for effective management of the CLSSA repair program.

Before 1994, each FMS customer country established an SLQ for each item according to its demand forecast. After the calculating method for SLQ and EPQ changed in 1994 (SAMIS calculates automatically SLQ according to demand history of each country and combines EPQs of each country), it became more important to manage the demand rate when submitting requisitions. Because the EPQ of an item is not visible to a country and the SLQ is the only guideline for requisitioning, it is actually hard for a customer country to ensure a certain level of programmed support. By submitting frequent requisitions of a small quantity instead of infrequent requisitions of a large quantity, however, a country can reduce the FMSO I case value and the liabilities over the excess assets, satisfying its demand level.

It is remarkable that the programmed ratio for most of the CLSSA requisitions increased significantly after the change in SLQ and EPQ application in 1994 and 1995. Because "programmed" means more chance of faster support than "non-programmed", that can be said to enhance the overall performance of the CLSSA program itself as well as the satisfaction of customer countries. Currently, more than 90 % of ROKAF's FMS budget are disbursed through the CLSSA program. Along with the Part Repair and Ordering System (PROS), a non-standard item support program, the CLSSA is the biggest component of the FMS program for ROKAF. It is expected that financial magnitude and coverage of the CLSSA program will be enlarged and strengthened in the future to meet the requirements of FMS customer country.

Programmed support

The second measurement question is to determine if "programmed requisitions" have a faster fill time than non-programmed requisitions. Customer countries believe that fill time of "programmed requisitions" should be faster than that of "non-programmed requisitions" as the algorithm of CLSSA indicates. So, this should be a question of verification of the CLSSA program, not a question of which is faster. The data analysis shows that, however, "programmed requisitions" were not always supported faster than non-programmed requisitions. ROKAF's requisition data for 1996 were analyzed within 5 categories between "programmed" and "non-programmed". The result indicates that the "programmed requisitions" were filled significantly faster for investment item repair (single priority), investment item procurement of low priority, and expense item procurement of low priority. In the case of requisitions for high priorities, however, the null hypothesis that requisition fill times between programmed and non-programmed are the same is not rejected at the significance level of 95 %. It can be concluded, therefore, that the expected advantage of timely support with faster fill time is not shown for requisitions of all the management categories.

If the inventory positions of the items are maintained over the control level at the source of supply most of the time, there would be no difference in fill time of "programmed" and "non-programmed" requisitions. Because the fill times of programmed requisitions of investment item repair, investment item procurement of low priority, and expense item procurement of low priority are shown to be faster than that of non-programmed requisitions, the inventory positions of those items are thought to be under the control level.

Role of priority

FMS customer countries use different priorities when submitting requisitions to accelerate the procurement lead-time or to designate the urgency for the specific items. After the null hypotheses were not rejected for the requisitions with high priority, it was suspected that relatively short procurement time made the differences in fill time not detectable. To see if the priority really impacts on the requisition fill time, the same data were compared between requisitions of high and low priority. The data analysis showed that high priority requisitions are not filled faster than low priority ones in all cases, not rejecting the null hypotheses that fill times of requisitions for high and low priority are the same at the significance level of 95 %. This indicates that the priority does not play its designed role in filling CLSSA requisitions. According to the asset release criteria, requisitions with high priority are to be filled until the zero asset level of inventory position, while requisitions of low priority are to be filled until a critical level is reached. Because there were no difference in fill time between requisitions of high and low priority, the inventory positions of most of items are thought to be maintained above the critical level.

Transportation time

Transportation pipeline segment is considered independent of the requisition filling process, because a customer country employs its freight forwarder and specifies appropriate modes of shipment. To measure the relative magnitude of transportation time for each type of requisition, in this research, the confidence intervals were shown for each management category. The result indicated that the transportation time of high priority

requisitions were faster than that of low priority requisitions as expected, because a country assigns air traffic mode to high priorities and sea traffic to low priorities.

Performance of the CLSSA

It is noticeable advancement that the programmed ratios of most of the CLSSA requisitions were increased with the change of application of parameters of the program (e.g., SLQ and EPQ) in that it increased the chances of faster supply support. The level of supply support will be said to be enhanced only when the subsequent reduction of requisition fill time is followed. Although the reduced faster requisition-fill time is the most important objective of the CLSSA program, this performance level is decided based on the varying inventory positions of sources of supply. It is difficult for a customer country to ensure a constant ratio of programmed requisitions or level of requisition fill time because a country does not know the status of the available asset levels or procurement process. Moreover, the chance of being programmed varies during the quarters when SLQ and EPQ are computed and applied. There is much higher probability of being programmed early in the quarter than later. Because customer countries can affect neither the programmed ratios of requisition nor level of fill times, it is most appropriate for the countries to maintain stable demand level within SLQ of each item and increase the chance of getting programmed support.

Customer countries would prefer high priority of requisitions, because they believe that it means faster supply support. However, there is no firm restriction to countries on the ratio of requisitions that can be submitted with each priority. Even more, there is no difference in cost of supply support between high and low priority. The data

analysis indicates that requisitions of high priority are not supported faster than those of low priority. If the priority factor is to influence the performance of the CLSSA program and play its role, the priority system should be reviewed, so that countries could get differentiated supply support with appropriate urgency needs.

Recommendations for further research

This research evaluated the supply responsiveness of the CLSSA program by measuring the requisition fill time distributions for 1996 ROKAF's requisition data. Due to the constraints on time and computer resources, the requisition data were utilized only for one year. It is evident fact that demand levels for items from customer countries vary continuously, because the policies on inventory management may be different for all countries. Also, the asset levels at sources of supply are to differ accordingly. Subsequently, it was hard to draw general conclusion on the performance of the CLSSA program based on the analysis of one country's data for one year. Furthermore, high priority requisitions were not differentiated from low priority ones in terms of supply responsiveness for all the management categories. In order to overcome the above limitations and get more conclusive result of analysis, following recommendations are addressed for future research on the FMS CLSSA supply support area.

1. Analysis of requisition fill time data of more than 3 years will depict more realistic performance and trend of the CLSSA program.
2. Comparison of requisition fill times of a FMS customer country with the USAF requisition data will show if the country requisitions are receiving the same treatment with the USAF's requisitions within priority system.

Appendix: Glossary of Terms

Air Force Security Assistance Center (AFSAC) - AFSAC is located at WPAFB, Ohio and is responsible for managing security assistance matters including FMS programs for the Air Force.

Air Logistics Center (ALC) - Air Force inventory control points as well as supply and maintenance depots that normally fill FMS requisitions

Arms Export Control Act (AECA) - The basic U.S. law providing the authority and general rules for the conduct of foreign military sales and commercial sales of defense articles, defense services, and training. The AECA came into existence with the passage of the Foreign Military Sales Act (FMSA) of 1968. An amendment in the International Security Assistance and Arms Export Control Act of 1976 changed the name of FMSA to the AECA.

Blanket Order FMS case - An agreement between a foreign customer and the U.S. Government for a specific category of items or services (including training) with no definitive listing of items or quantities. The case specifies a dollar ceiling against which orders may be placed.

Cooperative Logistics Supply Support Arrangements (CLSSA) - Military logistics support arrangements designed to provide responsive and continuous supply support at the depot level for U.S.-made military materiel possessed by foreign countries and international organizations. The CLSSA is normally the most effective means for providing common repair parts and secondary item support for equipment of U.S. origin which is in allied and friendly country inventories.

Force Activity Designator (FAD) - A Roman numeral (I to V), assigned by the Joint Chiefs of Staff, to show the mission essentially or a unit, organization, installation, project or program to meet national objectives.

Foreign Military Sales (FMS) - The selling of military equipment and services to friendly foreign governments and international organizations under the authority of the Foreign Assistance Act of 1961, as amended, and the Arms Export Control Act of 1976, as amended.

Foreign Military Sales (FMS) case - A United States of America Letter of Offer and Acceptance (LOA) or a "United States Department of Defense Offer and Acceptance," which has been accepted by a foreign country.

Foreign Military Sales Order I (FMSO I) - Provides for the pipeline capitalization of a cooperative logistics support arrangement, which consists of stocks on hand and replenishment of stocks on order in which the participating country buys equity in the U.S. supply system for the support of a specific weapons system. Even though stocks are not moved to a foreign country, delivery (equity) does in effect take place when the country pays for the case.

Foreign Military Sales Order II (FMS II) - Provides for the replenishment of withdrawals of consumption-type items (repair parts, primarily) from the DoD supply system to include charges for accessorial costs and a systems service charge.

Freight Forwarder - The agent designated by a SA customer country to complete or control FMS materiel shipment from CONUS or third countries to the purchaser's destination. This is usually a licensed international broker or freight forwarding agent.

Military Standard Requisitioning and Issue Procedures (MILSTRIP) - A DoD standard for automated logistics transactions. It defines a variety of records, differentiated by 3-position document identifier code, and a code used to requisition items and report status.

National Stock Number - A number assigned to each item of supply under the Federal Catalog System. It consists of the 4-digit Federal Supply Class, and 9-digit National Item Identification Number.

Nonstandard Item (NSI) - An item of supply determined by standardization actions as not authorized for procurement.

Not Mission Capable Supply (NMCS) - The condition of an item which renders the aircraft, equipment or system inoperable, and maintenance work cannot be performed to return it to an operational condition until the required item(s) of supply become available at the work site.

Repair and Replace (FMS) program - Programs by which eligible Cooperative Logistics Supply Support Arrangement (CLSSA) customers return repairable carcasses to the U.S. and receive a serviceable item without awaiting the normal repair cycle time frame. The concept is that the replacement involves an exchange of CLSSA customer-owned stocks in the customer's hands and the CLSSA customer-owned stocks in the USG inventory in the U.S. Countries are initially charged the estimated repair cost, with adjustment to the actual repair cost upon completion of repair of the carcass.

Security Assistance (SA) - A group of programs authorized by the Foreign Assistance Act of 1961, as amended, and the Arms Export Control Act of 1976, as amended, or other related statutes by which the U.S. provides defense articles, military training, and other defense-related services, by grant, loan, credit, or cash sales in furtherance of national policies and objectives.

Security Assistance Management Information System (SAMIS) - SAMIS is the AFSAC's computer network system which is used for managing and routing of FMS orders and requisitions.

Uniform Materiel Movement and Issue Priority System (UMMIPS) – Provides the basis for determining the relative importance of an item that is backordered by FMS supply from its wholesale source of supply. The system, in order to facilitate efficient requisitioning and materiel movement, uses a two digit numeric code (01 to 15) called a priority designator.

Urgency Need Designator (UND) – Indicates how urgently the organization requires the materiel ordered. The letters A, B, and C expresses the varying degree of urgency. UND A represents the highest need (cannot perform mission) followed in importance by UND B and UND C.

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Vita

Captain Mansik Hur was born on 3 September 1969 in Seoul, Korea. He graduated from Myeon-Mok High School in 1988 and attended the ROK Air Force Academy in Cheong-Ju. After he graduated with a Bachelor of Art degree in English Literature in 1992, he was commissioned as a supply officer and assigned to the Directorate of Supply Management in ROKAF Logistics Command in Taegu as an assistant budget control officer. During his tour, he served as a liaison officer at Joint U.S. Military Affair Group-Korea, Material Management Division-Taegu. In December 1994, he was assigned to the KTX-1 Research and Development Division at Aerospace Project Group in HQs ROKAF. He was promoted to captain in June 1995 and moved to the procurement management branch in the materiel management division in HQs ROKAF.

In February 1997, he married to Jisoo Ha and entered the Graduate School of Logistics and Acquisition Management at the Air Force Institute of Technology. Captain Hur graduated from AFIT in September of 1998 with a Master of Science degree in Acquisition Logistics Management.

Permanent address: Jungrang-gu Myeonmok 7dong 520-73
Seoul, Korea

REPORT DOCUMENTATION PAGE

Form Approved
OMB No. 074-0188

Public reporting burden for this collection of information is estimated to average 1 hour per reponse, including the time for reviewing instructions, searching existing data sources, gathering and maintaining the data needed, and completing and reviewing the collection of information. Send comments regarding this burden estimate or any other aspect of the collection of information, including suggestions for reducting this burden to Washington Headquarters Services, Directorate for Information Operations and Reports, 1215 Jefferson Davis Highway, Suite 1204, Arlington, VA 22202-4302, and to the Office of Management and Budget, Paperwork Reduction Project (0704-0188), Washington, DC 20503

1. AGENCY USE ONLY (Leave blank)	2. REPORT DATE	3. REPORT TYPE AND DATES COVERED
	September 1998	Master's Thesis

4. TITLE AND SUBTITLE

EVALUATION OF THE PERFORMANCE OF THE COOPERATIVE LOGISTICS SUPPLY SUPPORT ARRANGEMENT FOR ROKAF

5. FUNDING NUMBERS

6. AUTHOR(S)

Mansik Hur, Captain, ROK Air Force

7. PERFORMING ORGANIZATION NAMES(S) AND ADDRESS(S)

Air Force Institute of Technology
2950 P Street
WPAFB OH 45433-7765

8. PERFORMING ORGANIZATION REPORT NUMBER

AFIT/GAL/LAL/98S-5

9. SPONSORING / MONITORING AGENCY NAME(S) AND ADDRESS(ES)

10. SPONSORING / MONITORING AGENCY REPORT NUMBER

11. SUPPLEMENTARY NOTES

12a. DISTRIBUTION / AVAILABILITY STATEMENT

Approved for public release; distribution unlimited

12b. DISTRIBUTION CODE

13. ABSTRACT (*Maximum 200 Words*)

This thesis examines the performance of the Cooperative Logistics Supply Support Arrangement (CLSSA) for Republic of Korea Air Force (ROKAF). As one of the biggest FMS customer countries, ROKAF buys a substantial portion of its weapon systems from the U.S. Government and relies on the follow-on supply support from the source of acquisition. Because of the advantage of the CLSSA program for its timely support to foreign countries, the CLSSA has been the preferred method of follow-on supply support for FMS customer countries and its magnitude and coverage are being increased.

To find out the level of supply support for ROKAF, the programmed ratio of requisitions was summarized and the requisition fill times were analyzed statistically against key variables: programmed vs. non-programmed and priority of requisitions. The transportation time portion of the CLSSA program was also measured against different modes of shipment. For the statistical comparisons, one year's requisition data for 1996 were obtained from Air Force Security Assistance Center in AFMC, WPAFB OH. With the use of large sample z-tests, the statistical tests were performed; confidence intervals were constructed for the actual transportation times.

The test results showed that the programmed ratios of the CLSSA requisitions were increased significantly after the change in application of Stock Level Quantity and Eligible-to-be Programmed Quantity in 1994 over all FMS countries. Although the programmed requisitions were shown to be faster than non-programmed ones except for requisitions of high priority, the priority factor were not shown to play an expected role in requisition filling process. The transportation time was observed to be moderate depending on the specified modes of shipment.

14. Subject Terms	15. NUMBER OF PAGES
FMS, requisition fill time, ROKAF, supply support	69
	16. PRICE CODE

17. SECURITY CLASSIFICATION OF REPORT	18. SECURITY CLASSIFICATION OF THIS PAGE	19. SECURITY CLASSIFICATION OF ABSTRACT	20. LIMITATION OF ABSTRACT
UNCLASSIFIED	UNCLASSIFIED	UNCLASSIFIED	UL

AFIT Control Number AFIT/GAL/LAL/98S-5

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