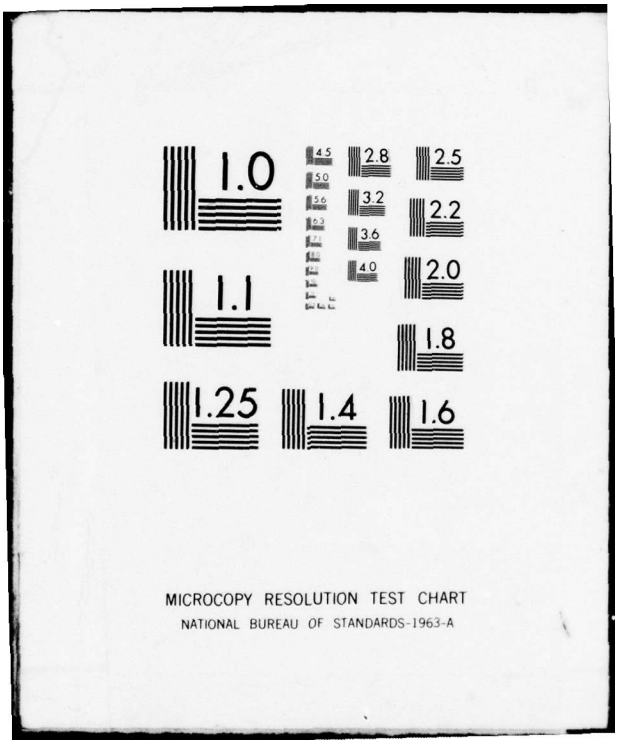
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AN ASSESSMENT OF RELEVANT DECISION-MAKING FACTORS USED IN THE PURCHASE OF REPROCUREMENT DATA

Robert L. Johnson, Captain, USAF
Mark A. Southwick, Captain, USAF

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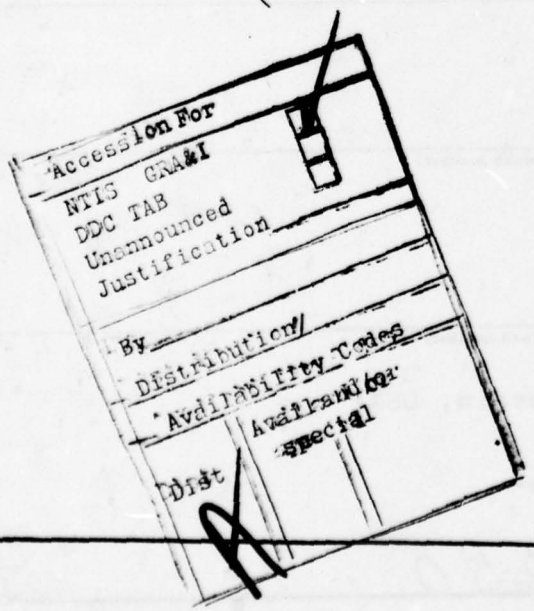
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The objectives of this research were to identify the factors considered in determining whether reprocurement data are purchased and to provide general guidance to assist Air Force managers in deciding whether to buy reprocurement data. A survey questionnaire was administered to Air Logistics Center Engineering Data Section personnel. Using factor analysis, three factors were identified as effecting the decision, in general, to purchase reprocurement data: the usefulness of reprocurement data, government policies and procedures, and the applicability of reprocurement data to mechanical items. The respondents indicated that the most important criteria in determining whether to purchase reprocurement data on specific items are the item's design stability, cost, and expected life in the inventory. A case analysis, utilizing a random sample of items in the C-130 aircraft, was also conducted. A relationship between Item Categories, as defined by the first two digits of the Federal Stock Number, and Annual Usage Rate was established. Item Categories were ranked according to Annual Usage Rate to provide an indication of the potential economic benefit of ownership of reprocurement data on those items.



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AN ASSESSMENT OF RELEVANT DECISION-MAKING FACTORS USED IN THE PURCHASE OF REPROCUREMENT DATA

A Thesis

Presented to the Faculty of the School of Systems and Logistics

of the Air Force Institute of Technology

Air University

In Partial Fulfillment of the Requirements for the

Degree of Master of Science in Logistics Management

By

Robert L. Johnson, BS
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June 1979

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This thesis, written by

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and

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has been accepted by the undersigned on behalf of the faculty of the School of Systems and Logistics in partial fulfillment of the requirements for the degree of

MASTER OF SCIENCE IN LOGISTICS MANAGEMENT

DATE: 13 June 1979

Darrell N. Fulton
COMMITTEE CHAIRMAN

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CHAPTER I

INTRODUCTION

Statement of the Problem

In 1973, Air Force Systems Command (AFSC) alone spent at least $250 million for reprocurement data (14:2). In many instances, reprocurement data are purchased even though the likelihood of reprocurement is very small. There needs to be an analysis of factors and techniques used to determine whether reprocurement data is purchased.

Justification

The Department of Defense purchases approximately six million pieces of technical data each year. The Air Force procures about one-half million pieces of technical data annually (7:1). In 1973, AFSC alone spent at least $250 million to purchase reprocurement data (14:2). This $250 million figure does not include costs of storage, handling, updating, duplication, and administrative costs, all of which would have to be added in order to determine the total costs associated with the ownership of reprocurement data.

The importance of reaching a sound decision as to whether to purchase data is reflected by the Armed Services

Procurement Regulation (recently redesignated as the Defense Acquisition Regulation) which directs:

> . . . delaying the ordering of technical data or computer software generated in the performance of the contract until such time as a need can be established and the requirements can be specifically identified for delivery under the contract [20:p.9:53].

Even though the amount of money involved is large, and the Armed Services Procurement Regulation (ASPR) directs a determination of a need for data before it is purchased, no specific guidelines are currently available to assist Air Force managers in their determination of whether to buy items of data. As a result, it has been estimated that as little as 5 percent of the reprocurement data currently purchased is ever actually used for procurement of spare parts.

Reprocurement data represents a substantial investment of money, manpower, and managerial talent. In this age of rising prices and tight budgetary constraints, it is one of the areas which could provide substantial cost savings.

Definitions and Terminology

Reprocurement data are a form of technical data. The ASPR states that data is "recorded information regardless of form or characteristic [20:p.9:53]." The regulation also defines technical data as "recorded information, regardless of form or characteristic, of a scientific or technical nature [20:p.9:27]." The ASPR gives examples of

technical data which include engineering drawings, research and engineering data, and process sheets. Technical data not only includes engineering drawings such as blueprints, but also includes information regarding the process of making an assembly or component (20:p.9:27). An example of a piece of technical data would be the temperature at which a steel part should be formed (5). Technical data may also contain information concerning the machinery needed to make certain parts. The inclusiveness of the term "technical data" is further revealed by the definition of "procurement data packages" given in MIL-STD-885B, Procurement Data Packages. This publication defines "procurement data packages" as

> . . . a generic term applicable to types of technical data when used for procurement purposes. It is a composite of specifications, plans, drawings, standards and such other data as may be necessary to describe existing material so they may be procured by the method contemplated [22:2].

Lieutenant Colonel Larry Schwartzman, in his Air War College thesis, "Reprocurement Data Costs Can Be Reduced," stated that the term "reprocurement data" had not been defined in official regulations. A search of the literature revealed that no definition had been added to government regulations since Schwartzman's review. For this thesis, Schwartzman's definition will be used: "Reprocurement data includes all data necessary to describe an existing item so that either an identical or interchangeable

item can be procured on a competitive basis." He went on to say that reprocurement data includes purchasing, manufacturing, and test data (14:11).

Purpose of Reprocurement Data

Schwartzman noted that the main purpose of reprocurement data is its role in procuring spare parts and replenishment items competitively, instead of having to rely solely on the original manufacturer for space parts needed during the life of the system. The government's intent is

> . . . to obtain lower prices by establishing additional competitive sources, while at the same time meeting the responsibility that the government has expressed to support small business [14:12].

Lee and Dobler stated that the use of competitive bidding for procurement requires that specifications be available (3:97). In order to competitively procure spare parts and replenishment items the government must have reprocurement data to provide the required specifications. These data allow procurement officials to comply with the ASPR which states that DOD policy is "to make all procurements on a competitive basis to the maximum extent possible [20:24]."

To understand what reprocurment data are and how they are used, a basic understanding of how they fit into the weapon systems acquisition process is useful. A brief

summary of the complex process of acquiring reprocurement data will now be presented.

Reprocurement Data Acquisition Process

The process of obtaining reprocurement data begins within the System Program Office at the beginning of the weapon system acquisition cycle. The System Program Office is a matrix-type organization, so a Program Manager is appointed during the conceptual phase of the weapon system acquisition process (12:10). The Program Manager appoints a Data Management Officer, who serves as the focal point for the management of data actions during the life of the program (18:4-5).

Following his appointment, the Data Management Officer issues a data call to all agencies which may have a potential need for data (18:5-7). Agencies that believe they have a need for data will respond to the data call by identifying what data they want and when they want it, and by substantiating their need for data (5).

After these data requests have been received by the Data Management Officer, they are reviewed in accordance with AFSCR 310-1. This review is accomplished by the Data Requirements Review Board, which is chaired by either the Program Manager or the Data Management Officer. This board screens all requests for data in an attempt to eliminate unnecessary requests. The revised list is

included as a contractor specification through the use of Department of Defense Form 1423, "Contract Data Requirements List." The contractor is then required to provide the data (18:1-14).

The decision regarding the purchase of specific items of reprocurement data is made during the weapon system acquisition process. A critical consideration is the method by which spares are to be purchased throughout the life of the system. Alternatives available include procurement through open competitive bidding or sole-source procurement of the component from the original manufacturer (23:2-5).

The government receives assistance from the contractor in making this decision. The government asks for the prime contractor's recommendations as to how spares should be acquired. The contractor responds by submitting the Contractor Recommended Codes (CRC) for procurement. These codes represent the contractor's recommended methods for procuring spares throughout the life of the system. Each item will be assigned one of three codes which are defined in MIL-STD-789B, Procurement Method Coding of Replenishment Spare Parts. If the contractor assigns a code of CRC 6, he is recommending that spares be procured through open competition. A code of CRC 7 means that the "spare part is recommended for procurement only from selected source(s) for reasons indicated by the suffix

code [23:3]." The suffix code conveys the contractor's reason for not recommending that the required spares be procured through open competition. For example, a suffix code of P means that "rights to use data for procurement of this spare part from additional sources are legally unavailable and cannot be acquired by purchase [23:4]." There are a total of eleven of these suffix codes listed in MIL-STD-789B. The third Contractor Recommended Code is CRC 8 which means that it is recommended that spares be obtained from "the prime contractor for reasons indicated by the suffix code whenever the prime contractor is not the actual manufacturer of the part [23:3]." A code of CRC 8 might be assigned, for example, when the prime contractor owns the tapes needed to operate numerically controlled machinery in the manufacturing of an item.

Following the submittal of the Contractor Recommended Codes, these codes are reviewed by government representatives. This review is normally accomplished by a review team from the Air Logistics Center which will have responsibility for the logistical support of the weapon system under consideration (5). This review culminates in the establishment of Procurement Method Codes (PMC), which identify the method by which spares will be acquired throughout the life of the system. This final decision as to the procurement method is reached through the review of the CRCs, negotiations with the prime contractor, and

consideration of other factors by the government review team. They may either adopt or reject the CRCs in formulating the PMCs (23:2-11).

This coding process helps answer the basic question as to whether reprocurement data is needed. If the item is coded as being suitable for procurement through open competition, reprocurement data will normally be needed to provide the required specifications during the open competitive bidding procurement process.

During the process of obtaining data, overall data management responsibility rests with the Program Manager. He delegates much of this responsibility to the Data Management Officer. After the program has been transitioned from AFSC to AFLC, the AFLC system or item manager assumes this overall responsibility (16:p.2-2).

After compiling the requested reprocurement data, the contractor forwards it to a data repository of the Air Force Engineering Data Support Center (AFEDSC), located at Wright-Patterson AFB, Ohio. AFEDSC receives and processes over one-half million pieces of data annually (19:3). These data are usually in the form of microfilm mounted on computer cards. A second copy of the data is sent to the Air Logistics Center having logistical responsibility for the item to which the data apply (5). When the Air Logistics Center determines that additional spares are needed,

the data can be removed from storage and used as specifications in the open competition procurement process.

This section presented a discussion of the activities taking place during the reprocurement data acquisition process. The overall flow of these activities is depicted in Figure 1.

Literature Review

The interest in reprocurement data as a research topic dates back at least as far as 1972. During that year, the quality of technical drawings purchased by the Air Force was discussed by Flint and Jesser in their thesis titled "Inspection and Acceptance of Contractor-Prepared Engineering Data." Flint and Jesser found that there were problems associated with the quality of reprocurement data purchased by the Air Force. The authors also discovered

> . . . that lack of satisfactory contractor-prepared engineering data in the Air Force inventory has precluded competitive procurement, prevented manufacture of needed spares, or hampered maintenance of end items [6:2].

Flint and Jesser reviewed many of the regulations and directives pertaining to reprocurement data. However, many of these regulations have since been deleted or revised.

Flint and Jesser revealed that, in many instances, data purchased by the Air Force were later determined to be inadequate for use as specifications for the procurement

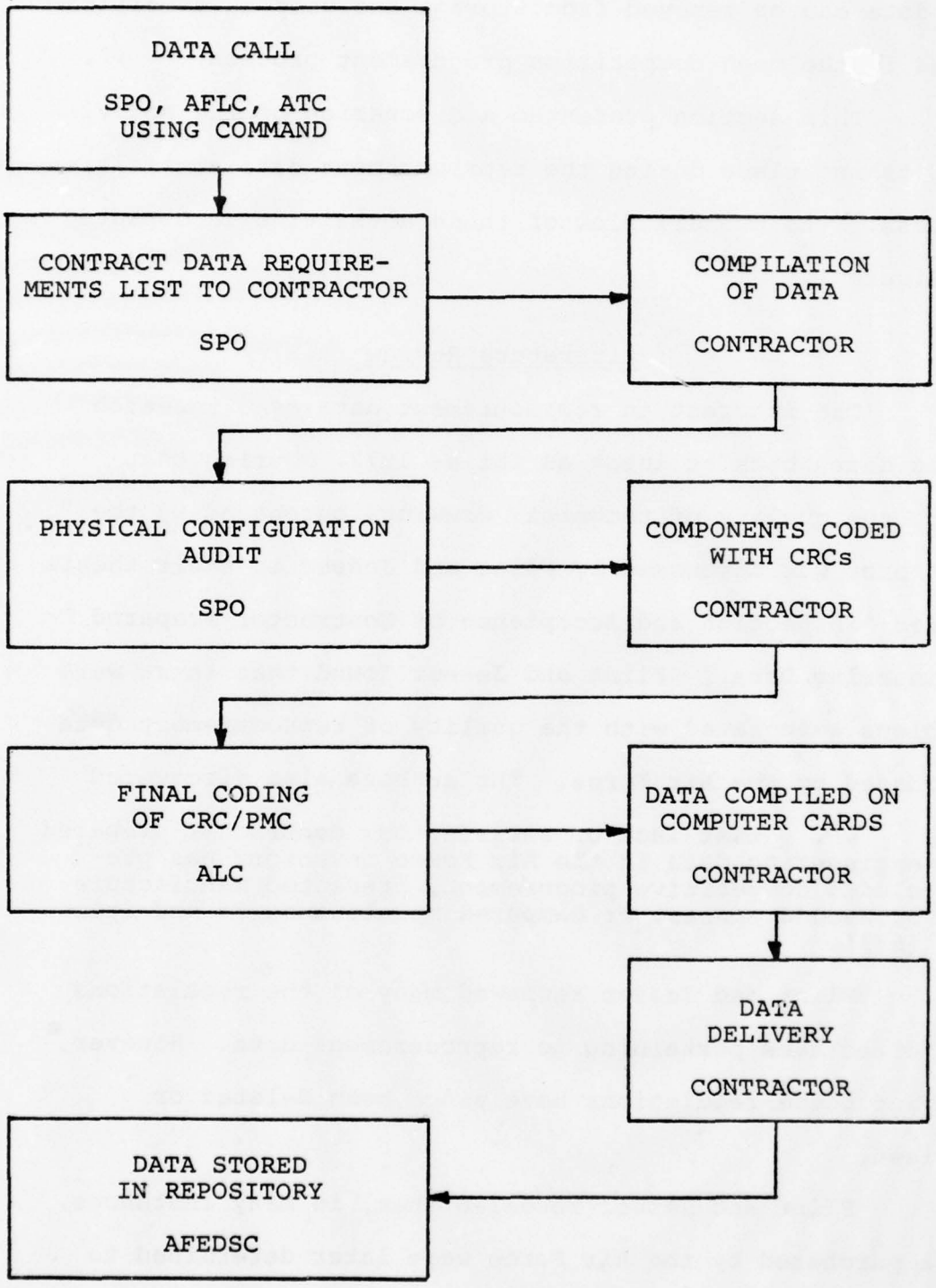


Fig. 1. Reprocurement Data Process

of spare parts through open competitive bidding. Defects in many reprocurement data packages made it impossible for contractors to build spares from information provided by the reprocurement data (6:2). The authors stated that this situation could be the result of a "lack of agreement between AFLC and AFSC people with regard to assignment of responsibilities for inspection and review of engineering data [6:34]." Flint and Jesser's research revealed that there was a definite lack of guidance concerning the amount of inspection to be given to technical data prior to its acceptance by the Air Force (6:35-36). It was also concluded that there was no formal program established to record information concerning the quality of technical data purchased by the Air Force or to record problems caused by inadequate data packages (6:37).

This research also revealed the possibility that many of the regulations concerning technical data were written at a level requiring knowledge greater than that possessed by many persons who must make use of these regulations. Flint and Jesser performed a Fog Count test on a sample of government publications dealing with procurement data. This test helped support an assertion that their sample of publications was unsuitable reading for anyone with less than a third-year-of-college reading ability (6:38-40).

Flint and Jesser recommended that reprocurement data be inspected by engineering personnel assigned to the Air Logistics Center having logistical support responsibility for the system in question. This inspection should be performed prior to the acceptance of the data. This inspection could either involve every item of data, or else a sampling procedure could be used to insure good quality control (6:46-50). The authors also recommended that publications and directives concerning procurement data be simplified in order to make them more understandable (6:50-52). This thesis concluded that substantial cost savings (between 11 percent and 20 percent of acquisition costs) would be achieved in the purchase of spares if all reprocurement data packages were adequate and complete (6:52-53).

Further research on the subject of reprocurement data was conducted by Lamb and Hause in 1974. The purpose of their thesis was

> . . . to examine the factors that may increase or decrease the cost that the Government (specifically the Air Force) pays for reprocurement data and to determine how much the Air Force should pay for reprocurement data [9:DD 1473].

The objective of this research project was to provide a conceptual framework for determining the price which should be paid for reprocurement data (9:12).

Lamb and Hause examined the question of the government's legal rights to technical data (9:26-38). They

also looked at the effect of government formatting on the cost of technical data (9:32-36). Another aspect studied was "the effect of the manufacturer's proprietary rights on the cost of reprocurement data [9:36]." These research areas were addressed through the use of case studies of several weapon systems contracts. The weapon system contracts analyzed were those of the C-5, F-5E, F-111, F-15, A-10, and B-1 procurements (9:44-58). This thesis included a detailed discussion of government directives pertaining to rights in technical data (9:29-32).

Lamb and Hause came to the conclusion that it is not possible to specify a dollar cost which should be paid for an item of reprocurement data. Efforts to accomplish this objective have been frustrated by the fact that costs attributable to reprocurement data are not readily identifiable. These costs are included in a single figure for all technical data produced by the contractor rather than being broken out in a separate cost account for reprocurement data. This is further complicated by a lack of consistency among contractors in accounting for the costs of technical data. The authors did conclude, however, that the costs associated with the acquisition of reprocurement data are considerable (9:59-60).

Although unable to give any exact dollar amounts, the authors stated that the government should pay "no more than reproduction and handling charges [9:65]" for

reprocurement data except in two special cases. The first case is when the contractor is required to produce the data in a form which is different from that in the original contract. The second case is when the government is buying unlimited rights in data which the contractor has developed at his private expense (9:65).

Lamb and Hause recommended that research be conducted on the subject of reprocurement data cost analysis. They stated that at the time of their research no such cost data could be found. The authors added that many contractors do not want to price reprocurement data separately (9:66).

In 1974, Schwartzman examined the reprocurement data acquisition process. He noted that there was no definition of the term reprocurement data given in official publications and formulated his own definition, which was presented previously in this thesis (14:11).

Schwartzman discovered several problems with regard to reprocurement data. He pointed out that there is pressure put on procurement officials to purchase and make use of reprocurement data in order to foster competition in government procurement. He pointed out that in many cases the use of open competitive bidding is not the most economical method to procure spares. In some situations, it may be more economical to not buy the data and, as an alternative, rely on sole-source procurement (14:64-65).

The author discovered that there were many instances in which there was real doubt as to whether reprocurement data should be purchased. He found two extreme views in these uncertain situations. Some procurement officials felt that reprocurement data should be bought whenever doubt existed, while others believed that data should not be purchased when there was a great deal of uncertainty as to its usefulness (14:16-17). It was also brought out that the desire for standardization was another pressure leading to the acquisition of reprocurement data (14:18-19).

Schwartzman discovered several other problems with the reprocurement data acquisition process. He stated that: "At the present time it is extremely difficult to obtain total cost figures for reprocurement data which accurately reflect both acquisition and ownership costs [14:38]." As may be recalled, this lack of cost information was noted in other research relating to reprocurement data. This lack of cost information makes it very difficult to determine the economic benefit derived from government ownership of reprocurement data. The author also discussed the problem of legal rights in contractor-prepared technical data. This data rights problem can make it impossible to use reprocurement data for the competitive procurement of spares in some instances (14:44). Schwartzman also revealed that there was some duplication of data purchases. He stated that the same data could be bought for two

different intended uses, and thereby paid for twice by the government (14:72). He also addressed the area of quality control. In many cases "the only agency capable of verifying accuracy of a large portion of the technical data is the contractor [14:46]." The author also asserted that the practice of storing reprocurement data at both the repository at Wright-Patterson AFB and at Air Logistics Centers is an unnecessary duplication of effort (14:74).

Schwartzman made several recommendations. He recommended that the Armed Services Procurement Regulation include definitions of various data categories (14:63). Another recommendation was that the ASPR emphasis on competition be deleted in favor of obtaining spares by the most economical method possible. The author also recommended that data procurement be handled by AFLC, which is the user of the data, rather than AFSC, which currently purchases the data (14:67-68). Another recommendation advanced was that a standard procedure for identification of data costs be implemented. Without this cost data, no concrete determination of the economic value of reprocurement data can be made (14:70). Schwartzman finally suggested that the responsibility for data inspection and acceptance be given to the Air Logistics Center Data Management Officer and

> . . . that he be given authority to impose sufficient contract provisions to shift the burden of proof

to the contractor that the data is suitable for competitive reprocurement [14:73].

In 1975, Vaillant studied the use of reprocurement data for purchasing mobile electric power generating sources used by the Department of Defense. The author emphasized the usefulness of reprocurement data in maintaining standardization of systems used by various DOD agencies. He did recognize, however, that this standardization could be achieved by relying on sole-source procurement, but that it was government policy to foster competition in federal procurement. This report also compared and contrasted the procedures used by the different military services in the procurement of mobile generating sources (25:1-26).

Vaillant stated that procurement of identical systems is possible through the use of reprocurement data, but revealed that several pitfalls do exist (25:24). For one thing, the technical data must be accurate and complete to be useful (25:12). The author also pointed out the data rights problem. In his view, the ideal situation would be for the government to always purchase unlimited rights in the needed data, but this is not always possible. As a result, some components of a system may have to be purchased on a sole-source basis (25:17-19).

This report pointed out that it is important that program managers be aware of the problems involved in obtaining adequate reprocurement data packages. Vaillant

stated that much emphasis should be placed on making sure that reprocurement data packages are both adequate and complete. Each program management office should form a "Configuration Control Board (CCB) in order to obtain absolute and total control of each configuration item [25:25]." The author also urged program managers to be fully aware of "the government's right to the data generated as a result of a development contract [25:25-26]."

During a recent interview, Lieutenant Colonel John D. Voss, Assistant Director of Procurement and Manufacturing for Aeronautical Equipment, strongly questioned the validity and usefulness of reprocurement data. He stated that the quality of reprocurement data is unsatisfactory "because the contractor is not motivated to give you good quality data or information that could eventually put him out of business." Voss suggested that because there is no motivation on behalf of the contractor to supply quality data, "there are thousands of loopholes that he can use to provide the government with inadequate data packages [26]."

Voss also suggested that in order to increase the amount of competition during the reprocurement cycle, management should take a more rigorous approach in its determination of whether to buy reprocurement data. He recommended that such a decision should consider "the simplicity of the item, technology, past reliability of similar data,

and the forecasted production rate." He suggested that if, after a thorough analysis, reprocurement data do not appear to be an effective vehicle to promote competition, then other procurement methods should be explored. Voss concluded by stating "I have never seen reprocurement data be used successfully yet [26]."

In a personal interview with Mr. John C. Powell, Chief, Procurement Division, Electronic Warfare SPO, Deputy for Aeronautical Equipment, he stated, "I generally think we ought to get it [reprocurement data]." He went on to explain that if reprocurement data are not purchased there is no recourse when a manufacturer goes out of business or discontinues that particular line. He further stated that if procurement officials have the data, they can go out and solicit bids for the supplying of that article and hopefully come up with some technically acceptable substitute. Mr. Powell stated "it is of prime importance to purchase reprocurement data on mechanical or electro-mechanical items that are not usually purchased by the average American citizen." He also stated "that frequently we will find errors in the data, and I believe the reason is that design changes that happen on the line do not always get to the primary engineering drawings [13]."

Powell concluded that

> . . . the purchase of reprocurement data on electronic equipment for complete systems is probably of

> not too much value; however, it may help that guy at the base purchasing office, five to six years from now when he's trying to buy replacement parts [13].

Mr. Charles L. Clark, Chief, Landing Gear and Mechanical Systems Division, Avionics and Aircraft Accessories SPO, stressed, in a personal interview, that his supervisors are always asking "what are you going to do about competition in the future?" He stated that the traditional reply has been "we are going to buy reprocurement data." He pointed out, however, that today there are many sophisticated systems which do not lend themselves to the use of reprocurement data (2).

Clark stated that the biggest fallacy is not reprocurement data itself, but that the government has not taken the appropriate actions to make it work. He cited several problems frequently encountered when reprocurement data are used. First, he explained that every manufacturing company is unique, and thus, there are many manufacturing processes and techniques that are not readily transferable to another firm. Secondly, he explained that a manufacturer may purposely supply bad data to protect his own interests. The government's only recourse to prevent this problem is to insure quality data by the development of a quality control program. However, Clark stated that "the government does not have the capability to determine if the quality of data is sufficient." Finally, Clark explained that by the time you go through the process of validating your data, and

taking those actions necessary to transfer its utility to another firm, you do not have sufficient time to actually manufacture the item to meet your commitments in the field. In conclusion, Clark stated:

> If you looked at all the times reprocurement data was purchased versus the times it's been used, you would find a tremendous disparity. I would estimate that we have purchased reprocurement data on 90 percent of the items we buy and have tried to use it on maybe 3 percent [2].

In summary, this literature review revealed several consistencies among some of the sources. Five of the seven sources revealed a belief that a quality control problem exists. It was felt that much of the reprocurement data being purchased by the Air Force is of insufficient quality. Schwartzman agreed with Flint and Jesser that government regulations concerning reprocurement data were vague and in need of revision.

Research Objectives

The research objectives of this research were:

1. To identify the factors considered in determining whether reprocurement data are purchased.

2. To provide general guidelines which will assist Air Force managers in deciding whether to purchase reprocurement data.

Research Questions

In order to accomplish the research objectives, the following research questions were answered:

1. What factors are considered in determining whether reprocurement data should be purchased?

2. What decision rules should be used to determine if reprocurement data should be purchased?

CHAPTER II

METHODOLOGY

Overview

The objectives of this research effort are to identify the factors considered in determining whether reprocurement data are purchased, and to provide general guidelines which will assist Air Force managers in deciding whether to purchase reprocurement data. Because the data needed to accomplish these objectives were not available, two methods of data generation had to be employed: a survey questionnaire and a case analysis.

The questionnaire was used to gather information concerning the importance of various factors considered by Air Force managers in their decisions to determine if reprocurement data should be purchased. The case analysis was used to analyze the characteristics of an item which appear to significantly affect the need for replenishment items and spares during the time the item is in the active Air Force inventory. This information will assist the decision maker in recognizing the relationships between categories of items and the expected usage rate of reprocurement data. The C-130 transport aircraft was chosen for this case analysis research effort.

Sampling Plan

Universe

The universe for the case study analysis consisted of all procurements of replenishment items and spare parts for the C-130 aircraft.

Population

The population for the case study consisted of all Air Force procurements of replenishment items and spare parts for the C-130H aircraft from 1 July 1972 to 1 October 1978.

Data Collection

Since both a questionnaire and a case analysis were used to gather data, two separate data collection plans had to be devised. For the survey questionnaire, a census approach was employed to survey all thirty-six Air Logistics Center Engineering Data Section personnel. The case analysis data collection plan utilized a sample of C-130H items.

Questionnaire

Questionnaire Design

The survey questionnaire was designed to highlight the factors that are currently being used by Air Logistics Center Engineering Data Section personnel to determine whether to purchase reprocurement data on items and systems

being purchased by the Air Force. The Engineering Data Section has the primary responsibility in determining whether to purchase reprocurement data, in providing the chairperson for Contractor Recommended Code (CRC) verification conferences, and in determining the Procurement Method Code (PMC). The Engineering Data Section is also responsible for keeping the contractor and item management personnel informed of PMCs. No PMC can be changed without the concurrence of the Engineering Data Section (21:2-3).

The questionnaire was designed to reveal the relative importance of eight factors in the decision whether to acquire reprocurement data. Five of these factors were discovered by the authors during their literature review:

1. The decision maker's estimate as to how long the item will be in the Air Force inventory.

2. The requirement of the Armed Services Procurement Regulation for Air Force managers to foster competition in making government procurements.

3. Reprocurement data provides a method of procuring replenishment items and spares in the future, should the original source of supply go out of business.

4. The lack of alternatives to the use of reprocurement data in being able to foster competition in making government procurements.

5. The design stability of the item. This refers to the rate of technological change which will determine the item's point of obsolescence.

The researchers added three factors not revealed during the literature review:

1. The type of item under consideration (such as electronic, aircraft component, aircraft accessory).

2. The cost of the reprocurement data.

3. The cost of the item to which the reprocurement data applies.

The first of the three additional factors was added in order to be able to compare and integrate the results of the case analysis and the survey questionnaire. The two remaining additional factors were included to assess the consideration being given to economic factors in reprocurement data buying decisions. A copy of the questionnaire used for this research appears in Appendix A.

For the survey, a listing of all Engineering Data Section management personnel was requested from each Air Logistics Center, with thirty-six people identified. Each individual was sent a survey questionnaire with a request (Appendix B) to complete the questionnaire within one week.

Testing the Questionnaire

The validity of the questionnaire was tested in two phases prior to being sent to the Engineering Data Section

personnel. The first phase consisted of critiques by three experts on the faculty of the School of Systems and Logistics. Following these critiques, the questionnaire was revised using the suggestions of the three faculty members.

To avoid using a portion of the population for testing, the second phase of the testing utilized personnel stationed at Wright-Patterson Air Force Base who have data management backgrounds. Interviews with these individuals established that they were very familiar with the subject of reprocurement data, so it was felt this testing would yield valid results. Six individuals were asked to complete the questionnaire and provide written critiques. The test group was then interviewed to gain further information concerning the validity of the questionnaire. This testing supported the validity of the questionnaire.

Case Study

Case Study Design

The C-130 aircraft was selected as the system to be used for the case study. The first C-130A was delivered to the Air Force in December 1956. Since that time many modifications have been made to the C-130 and several different models have been produced (i.e., C-130B, C-130D, etc.), the latest of which is the C-130H (31:96).

The C-130 was selected for the case analysis research effort because this aircraft has been in the Air

Force inventory a relatively long period of time, providing a long history of procurements of replenishment items and spare parts. The researchers also felt that the items in the C-130 would be representative of the types of aircraft items purchased by the Air Force. Finally, since one of the researchers had been a C-130 navigator for five and one-half years, the researchers would be familiar with applications for the items being reviewed.

The case analysis was an effort to highlight categories of replenishment items and spare parts whose frequency and quantity of purchase indicate a high usage item. The generalizations drawn from this analysis were compared with the conclusions reached from the analysis of the survey questionnaires. The information obtained from the two research tools was used in deriving general guidelines to assist Air Force managers in deciding whether to purchase reprocurement data.

Data Collection

Random sampling was employed for the data collection needed for the case analysis. Random sampling is superior to nonprobability sampling in that by "randomization the danger of unknown sampling bias is minimized [4:164-165]." In carrying out the sampling, a listing of all items included in the C-130H was obtained from Warner Robins ALC. Since this research focused on Air Force

purchasing of reprocurement data, only Air Force-managed items were included in the sample.

The following formula was used in ascertaining that the selected sample size of 126 items was adequate (4:148-153).

$$N = \frac{P(1-p)}{\sigma_p^2}$$

where,

N = sample size,

P = the sample proportion, and

σ_p = standard error of the proportion computed from the sample.

$$\sigma_p = \frac{.10}{1.96} = .051$$

The sample size was computed such that the researchers would be 95 percent confident that the population parameter was within ± .10 of the sample proportion. The researchers set P equal to .5 in order to establish a maximum required sample size. The computation of the sample size follows.

$$N = \frac{P(1-p)}{\sigma_p^2} = \frac{.5(1-.5)}{(.051)^2} = 96.117$$

Following the random selection of each item, the Special Procurement History Extraction (AFLC Form J041.E9LK) covering each item was reviewed. The History Extraction is

maintained for every item in the Air Force inventory. The History Extractions utilized for this research provided a history of the procurements of the item from 1 July 1972 to 1 October 1978. The History Extraction indicates such information as the method by which each procurement was made (i.e., sole-source, open competition, etc.), the date each procurement was made, and the quantity of items which were procured. The data utilized for this research effort was the number of replenishment items and spare parts purchased, the cost of the items procured, and the method of procurement.

Data Analysis Plan

This section outlines the data analysis plan used to carry out this research. Two data analysis plans were used. The first data analysis plan to be presented is the plan used for analyzing the data generated by the survey questionnaire. This will be followed by a discussion of the data analysis plan utilized for the case analysis.

Survey Questionnaire Data Analysis Plan

The technique of factor analysis was employed to analyze the data obtained from the questionnaires. Factor analysis was chosen due to its data-reduction capability which enables the researcher to observe underlying patterns of relationships. Through the use of this tool, the data

can be rearranged into a set of factors. Factor analysis is used for the following applications:

1. To explain and detect the patterning of variables.

2. To test hypotheses concerning the structuring of variables in relation to the anticipated number of significant factors and factor loadings.

3. To construct indices which may be used as variables in follow-on analysis (11:469).

The first major step in conducting a factor analysis is to prepare the correlation matrix. This is followed by extracting the initial factors and exploring the possibility of data reduction. The third major step is to search for simple and interpretable factors (11:469).

The term "factor-analysis" includes a variety of procedures. For this research effort, classical-factor analysis was used. Classical-factor analysis is "based fundamentally on the faith that the observed correlations are mainly the results of some underlying regularity in the data [11:471]." The researcher is assuming that the observed variables are influenced by various determinants, and that a portion of the determinants are shared by other variables included in the set, while other determinants are not shared by any other variable. The portion of the variable effected by shared determinants is called common, "and the part that is influenced by idiosyncratic determinants

is usually called unique [11:471]." It is assumed that the unique part of a variable makes no contribution to relationships among variables. It follows from this assumption that observed correlations are the result of correlated variables sharing some of the common determinants. The researchers' belief "is that those assumed common determinants will not only account for all the observed relations in the data, but will also be smaller in number than the variables [11:471]." The basic classical-factor analysis model is as follows:

$$Z_j = a_{j1}F_1 + a_{j2}F_2 + \ldots + a_{jm}F_m + d_jU_j \quad j=1,2,\ldots,n$$

where,

Z_j - variable j in standardized form,

F_i = hypothetical factors,

U_j = unique factor variable j,

a_{ji} = standardized multiple-regression coefficient of variable j on factor i (factor loading), and

d_j = standardized regression coefficient of variable j on unique factor j.

The following correlations are assumed to hold among the hypothesized variables:

$$r_{(F_iU_j)} = 0 \quad i = 1,2,\ldots,n;\ j = 1,2,\ldots,n;\ \text{and } i \neq j$$

$$r_{(U_jU_k)} = 0 \quad j \neq k$$

It is assumed that the unique factor (U_j) is not correlated with the common factors nor with unique factors associated with other variables. Because of this, it is assumed that any correlation between two variables is due to the common factors (11:471).

Two other terms which were used in the data analysis chapter are eigenvalue and communality. Communality is the "total variance of a variable accounted for by the combination of all common factors [11:475]." It can be expressed by the following formula:

$$h_1^2 = a_{11}^2 + a_{12}^2 + a_{1i}^2$$

where,

h_1^2 = communality, and

a_{ji} = standardized multiple-regression coefficient of variable j on factor i (factor loading).

Eigenvalue, which may be expressed by the following formula, indicates the "amount of total variance in the data accounted for by a specific factor [11:75]."

$$\text{Eigenvalue} = \sum_{j=1}^{N} a_{ji}^2$$

In conducting the factor analysis, the standard SPSS factor analysis program was employed.

Case Study Data Analysis Plan

The information obtained from the Special Procurement History Extraction included the total number of items which were procured from 1 July 1972 to 1 October 1978. This information was used to determine an Annual Usage Rate for each item included in the sample. Annual Usage Rate is a ratio expressing the total quantity of items purchased divided by the total number of years covered by the History Extraction.

The items included in the sample were grouped into sixteen categories based on the Federal Supply Area Assignment as indicated by the first two digits of the Federal Stock Number. Area assignments represent "broad engineering disciplines, practices and manufacturing technologies [24:v]." The seventy-seven area assignments included in the federal classification system are listed in Appendix C (24:2-20). Sixteen area assignments (asterisked in Appendix C) were used as categories for the case analysis.

Following the categorization of each item, a chi-square contingency table was constructed. "Contingency means independence, so a contingency table is simply a table that displays how two or more characteristics depend on each other [23:511]." The chi-square contingency table is a systematic method of determining and tabulating the expected frequencies (E_{ij}) and the observed frequencies

(O_{ij}) of each cell. The expected frequency (E_{ij})is calculated as follows:

$$E_{ij} = N\hat{\Pi}_i \hat{\Pi}_j$$

where,

$\hat{\Pi}_j$ is the frequency in a respective column marginal,

$\hat{\Pi}_i$ is the frequency in a respective row marginal, and

N stands for the total number of valid cases (30:512).

The observed frequency (O_{ij}) is the observed frequency in any given cell. The two sets of frequencies are then compared by computing the chi-square statistic, which depends upon the differences between the observed frequencies and the corresponding expected frequencies. The chi-square statistic for independence is computed as follows (30:513):

$$\chi^2 = \Sigma\Sigma \frac{(O_{ij} - E_{ij})^2}{E_{ij}}$$

The computed chi-square statistic (χ^2) is then compared with the known theoretical distribution of chi-square in order to determine whether the value of chi-square is significantly different from zero. If the value of chi-square is statistically significantly different from zero, the null hypothesis of statistical independence can be rejected (30:511-515).

For this research effort, the two variables in the chi-square contingency table were Annual Usage Rate and the Federal Supply Area Assignment of the item. The dependence of the procurement rate on the item's category was analyzed.

Assumptions

Assumptions of the Questionnaire Research

The following assumptions were made in designing the methodology of the survey questionnaire research:

1. The respondents provided honest and factual answers based on their knowledge, opinions and perceptions.

2. The measurement scales used in the questionnaire provided ordinal level data.

Assumptions of the Case Analysis Research

The following assumptions were made in designing the methodology for the case analysis research:

1. The sample of C-130 procurements used was representative of the population of all C-130 procurements of replenishment items and spare parts.

2. All procurements of C-130 items have been accurately recorded on the Special Procurement History Extractions.

3. The ownership of reprocurement data on items having a high Annual Usage Rate would be of greater economic

value than ownership of reprocurement data on items experiencing a lower Annual Usage Rate.

Limitations

Limitation of the Case Analysis Research

The following limitation applies to the case analysis research:

The inferences drawn from the case analysis research are only applicable to the C-130H aircraft system.

Limitations of the Questionnaire Analysis

The following limitations apply to the survey questionnaire analysis:

1. The population size was relatively small for the use of factor analysis. Thus, an increase in the number of observations could result in a change of the factors.

2. The conclusions drawn from this analysis are representative of Engineering Data Section personnel. Although they have the primary responsibility for making reprocurement data buying decisions for AFLC, other Air Force managers are also involved.

CHAPTER III

CASE STUDY DATA COLLECTION AND ANALYSIS

Overview

This chapter describes the data collection and analysis used for the C-130 case analysis. The purpose of the case analysis was to identify the characteristics of an item that appear to be related to the item's Annual Usage Rate. The researchers felt that this information could be useful in developing general guidelines to assist Air Force managers in their determination of whether to purchase reprocurement data on items entering the Air Force inventory. The underlying assumption was that ownership of reprocurement data on items having a high Annual Usage Rate would be of greater economic value than ownership of reprocurement data on items experiencing a lower Annual Usage Rate. This is because the savings resulting from buying competitively instead of sole-source will be greater for those items experiencing a larger number of purchases, as opposed to those purchased in lesser quantities.

The researchers examined the relationship between categories of items and Annual Usage Rate during the period of 1 July 1972 to 1 October 1978 for the C-130H aircraft system. For this analysis items were grouped into categories

based on the first two digits of each item's Federal Stock Number. The researchers also examined the relationship between Annual Usage Rate and the item's price as well as Annual Usage Rate and the method by which an item had been procured (i.e., competitive or noncompetitive). The information uncovered through this case analysis was combined with the information revealed by the analysis of the survey questionnaire (described in the following chapter) in deriving general guidelines to assist in making reprocurement data buying decisions.

Data Collection

The first step in the data collection process for the case study was the obtaining of a copy of the C-130H Follow On Supply Support List (FOSSL) from Warner Robins ALC. The FOSSL lists 22,000 items included in the C-130H. Information presented by the FOSSL includes each item's Federal Stock Number, a brief description of the item, and the agency responsible for the management of the item (29). The FOSSL used for this research, dated 12 August 1977, was the most recent one available.

The FOSSL was used to obtain a random sample of 126 Air Force managed Federal Stock Numbered items included in the C-130H aircraft system. Since only Air Force managed items were included in the population, each item

in the sample was managed by one of the five AFLC Air Logistics Centers.

The second step in the data collection process was to obtain a history of procurements on all items which had been included in the random sample. This information was collected from a Special Procurement History Extract that was obtained from the Air Logistics Center which managed each item. The History Extracts listed all procurements of C-130H replenishment items from 1 July 1972 to 1 October 1978. This time frame was selected because the current system used in reporting this information was not in use prior to 1 July 1972. The information obtained from the History Extracts on each item included in the sample was:

1. The total quantity purchased.
2. The total amount paid for each purchase.
3. The Actual Method of Procurement (AMOP) used in making each purchase.

For each buy of an item an AMOP code is normally assigned. The six AMOP codes along with their description are listed in Table 1.

In compiling the data, each item's Annual Usage Rate was calculated as explained in Chapter II. The average price per item paid for all procurements of each item during the selected time frame was also calculated. For those items which had not been procured during the time frame

TABLE 1

ACTUAL METHOD OF PROCUREMENT CODES (17:A1-1)

Code	Explanation
0*	This code is machine assigned when PMC is "00", in order to signify that the item is not reportable under AFR 57-6.
1	Current procurement is competitive, and the item was previously purchased competitively.
2	Current procurement is competitive, and the item is being purchased competitively for the first time.
3	Current procurement is noncompetitive from the actual manufacturer or a vendor, including a prime contractor who is the actual manufacturer.
4	Current procurement is noncompetitive, and the item is being purchased directly from the actual manufacturer or vendor for the first time rather than the original prime contractor for the end items for which the parts support.
5	Current procurement is noncompetitive, and the item is being purchased from a prime contractor who is not the actual manufacturer.

*Generally, this code is only assigned to items experiencing their first purchase. A code of "00" is usually assigned just once and allows the purchase to be processed through the JO41 system.

analyzed (items with 0.0 Usage Rate), the price for the item listed in the FOSSL was used.

Most of the items included in the sample had been procured several times. For many of these items, different buys had been assigned various AMOPs. Because of this, it was necessary to calculate and use median AMOPs for the analysis. The median was chosen due to the ordinal nature of the data (from competitive to noncompetitive). In computing the median AMOP, a midpoint was determined by dividing the total quantity of the item purchased by two. The buys were then listed in order from most competitive (AMOP of 1) to least competitive (AMOP of 5). The AMOP for the buy falling at the midpoint of this list was designated as the median AMOP. To illustrate this computation, assume the following data:

Buy	Quantity	AMOP
1	50	1
2	50	2
3	60	3
4	20	3
Total Quantity	180	

The total quantity divided by two equals ninety. Using the procedure described, the ninetieth data point occurs during the second buy, and the median AMOP would be two.

Each item included in the sample was identified to one of seven Item Categories based on the first two digits of the item's Federal Stock Number. Table 2 indicates the resulting categorization.

TABLE 2

CATEGORIZATION OF SAMPLE ITEMS

Item Category	Supply Area*	Description
1	58	Communication, Detection and Coherent Radiation Equipment
2	53	Hardware and Abrasives
3	15	Aircraft and Airframe Structural Components
4	16	Aircraft Components and Accessories
5	28	Engines, Turbines and Accessories
	29	Engine Accessories
6	66	Instruments and Laboratory Equipment
7	17, 30, 31 40, 43, 47 48, 59, 61	Miscellaneous

*First two digits of Federal Stock Number.

Data Analysis

Measurement Level of the Data

In evaluating the data's scale of measurement, the researchers determined that Annual Usage Rate and Price Per Item had been measured on the ratio scale. Actual Method of Procurement (AMOP) had been measured on the ordinal scale, and Item Category represented nominal level data.

Statistical Tests

It was decided that three nonparametric measures of correlation would be used: the Spearman Rank Correlation Coefficient, the Kendall Rank Correlation Coefficient, and the Contingency Coefficient.

The Spearman Rank Correlation Coefficient was used in examining the relationship between Annual Usage Rate and Price Per Item. Although both Annual Usage Rate and Price Per Item were measured on the ratio scale, it was felt that not all of the assumptions required of a parametric test had been adequately met. One of these assumptions is that the observations be drawn from normally distributed populations. It was not felt that the Price Per Item variable had been drawn from a normally distributed population. This was based on an examination of the Coefficient of Skewness for the Price Per Item observations.

The Coefficient of Skewness is based on the spread between the arithmetic mean and the median and can be calculated from the following formula.

$$Sk = \frac{3(\bar{X} - Md)}{s}$$

where,

$\bar{X}$ = the mean,

Md = the median,

s = the standard deviation, and

Sk = Coefficient of skewness.

For the sample of Price Per Item observations, the observed mean was 836.005, the median was 28.005 and the mode was 2.1. The Coefficient of Skewness was computed to be 6.372. The Coefficient of Skewness would be zero for a symmetrical or normally distributed distribution.

The Kendall Rank Correlation Coefficient was used in examining the relationship between Usage Rate and AMOP, since AMOP was measured on the ordinal scale. The Kendall Correlation Coefficient was chosen for this analysis because of the large proportion of tied ranks occurring within the AMOP variable.

Since Item Category is nominal level data, neither the Spearman nor the Kendall Coefficient could be used to examine the relationship between Item Category and Usage Rate. The Contingency Coefficient was chosen for analyzing this relationship.

Relationship Between Annual Usage Rate and Price Per Item

The standard SPSS program available on the CREATE computer system was used to calculate the Spearman Rank Correlation Coefficient (r_s) relating Annual Usage Rate to Price Per Item. The value of r_s was computed to be -.3503.

According to Siegel, when the sample size (N) is 10 or larger the following formula can be utilized in testing the significance of the Spearman Rank Correlation Coefficient (15:212).

$$t = r_s\sqrt{\frac{N-2}{1-r_s^2}}$$

where,

t = Student's t,

r_s = Spearman Rank Correlation Coefficient, and

N = sample size.

The significance of the computed r_s (-.3503) was tested at a signifiance level of .10 (α=.10) which was set arbitrarily by the researchers. The sample size (N) was 126. The significance test follows.

H_0: There is no relationship between Annual Usage Rate and Price Per Item.

H_a: There is a relationship between Annual Usage Rate and Price Per Item.

Degrees of Freedom (df) = N-2 = 124.

$$t = r_s\sqrt{\frac{N-2}{1-r_s^2}} = -.3503\sqrt{\frac{126-2}{1-(-.3503)^2}}$$

$$t = -4.165$$

Critical value of t using Student's t distribution = -1.658.

Decision Rule: If the computed t is less than the critical value, H_0 can be rejected.

Therefore, since -4.165 < -1.658, H_0 can be rejected.

The preceding test indicated that there is a relationship between Annual Usage Rate and Price Per Item. This test has provided statistical evidence that lower priced items have higher usage rates than higher priced items.

Relationship Between Annual Usage Rate and AMOP

The SPSS computer program calculated the Kendall Rank Correlation Coefficient (Tau c) relating Annual Usage Rate and AMOP as being -.3242.

According to Siegel, when the sample size (N) is 10 or larger, Tau c may be treated as being normally distributed and the following formula may be used to test the significance of Tau c (15:220-222).

$$Z = \frac{\text{Tau c}}{\sqrt{\frac{(2(2N+5)}{9N(N-1)}}}$$

where,

Z = standard normal variable,

N = sample size, and

Tau c = Kendall Rank Correlation Coefficient.

The significance of the computed Tau c (-.3242) was tested at a significance level of .10 (α=.10) which was set arbitrarily by the researchers. This test follows.

H_0: There is no relationship between Annual Usage Rate and AMOP.

H_a: There is a relationship between Annual Usage Rate and AMOP.

$\alpha = .10$.

$$Z = \frac{\text{Tau c}}{\sqrt{\frac{2(2N+5)}{9N(N-1)}}} = \frac{-.32419}{\sqrt{\frac{2(2(81)+5)}{9(81)(81-1)}}}$$

$$Z = -4.28$$

Critical value of Z using Normal Distribution = -1.645.

Decision Rule: If the computed Z is less than the critical value, H_0 can be rejected.

Therefore, since -4.28 < -1.645, H_0 can be rejected.

The preceding test indicated that there is a relationship between Annual Usage Rate and AMOP. Statistical evidence indicates that the larger the quantity of an item that has been purchased, the more likely it is that the purchase was made through competitive means.

Relationship Between Annual Usage Rate and Item Category

The two variables analyzed using the Contingency Correlation Coefficient were Annual Usage Rate and Item Category. The Contingency Coefficient was used because Item Category was measured on the nominal scale.

The first step in computing the Contingency Correlation Coefficient is the construction of a Chi-Square Contingency Table. One of the limitations of using the Chi-Square Contingency Table is that when the degrees of freedom are greater than one, the table "should not be used when more than 20% of the expected frequencies are smaller than 5 or when any expected frequency is smaller than 1 [15:46]." This limitation was the driving force behind the researchers' determination of the number of Annual Usage Rate intervals and Item Categories which were employed in the contingency table.

The first step in this process was the categorization of items included in the sample according to the first two digits of each item's Federal Stock Number. The seven resulting categories were based on the natural groupings of the 126 items included in the sample. Table 3 lists the classifications included in the sample, the category into which each classification was placed, and the number of items selected from each classification. It can be seen from the table that items with stock numbers beginning with

TABLE 3

CLASSIFICATIONS INCLUDED IN THE SAMPLE

Classification	Item Category	Description	Number of Items
15	3	Aircraft and Airframe Structural Components	23
58	1	Communication, Detection & Coherent Radiation Equipment	21
16	4	Aircraft Components and Accessories	19
53	2	Hardware & Abrasives	15
66	6	Instruments & Laboratory Equipment	10
28	5	Engines, Turbines and Components	15
29	5	Engine Accessories	8
47	7	Pipe, Tubing, Hose & Fitting	3
48	7	Valves	3
30	7	Mechanical Power Transmission Equipment	2
59	7	Electical & Electronic Equipment Components	2
17	7	Aircraft Launching, Landing and Ground Handling Equipment	1
31	7	Bearings	1
40	7	Rope, Cable, Chain & Fittings	1
43	7	Pumps and Compressors	1
61	7	Electric Wire & Power Distribution Equipment	1

either 15, 16, 53, 58, or 56 were placed into single categories. Items with stock numbers beginning with either 28 or 29 were combined into one category because both are related to engines. The remainder of the items were placed into a Miscellaneous category.

Having decided to use seven categories of items, the researchers were limited to using three Annual Usage Rate intervals in order to satisfy the limitation that no more than 20 percent of the expected frequencies can be smaller than five. The three Annual Usage Rate intervals were established such that the expected value of observations in each interval would be approximately equal. The three by seven contingency table which was constructed is shown in Table 4. The number of observations in each cell is shown along with each cell's contribution to chi-square (in parenthesis).

Both the χ^2 statistic and the Contingency Coefficient were computed by the SPSS program. The χ^2 statistic was computed to be 23.3419 and the Contingency Coefficient was determined to be .395.

The χ^2 statistic is used in testing for the significance of the Contingency Coefficient. If the observed χ^2 is statistically significant, the null hypothesis of no relationship may be rejected (15:196-200). The test for the significance of the Contingency Coefficient is shown next.

TABLE 4

CHI-SQUARE CONTINGENCY TABLE

	Category							
Usage Rate	1	2	3	4	5	6	7	
0.0 to 2.2	9 (.533)	5 (.000)	9 (.223)	2 (2.935)	8 (.013)	5 (.902)	4 (.215)	42
2.3 to 109.0	11 (2.032)	1 (3.363)	7 (.001)	10 (1.982)	5 (1.011)	3 (.047)	6 (.133)	43
110.0 to 20,000	1 (4.947)	9 (3.407)	7 (.000)	7 (.112)	10 (.889)	2 (.500)	5 (.002)	41
	21 (7.51)	15 (6.77)	23 (.22)	19 (5.03)	23 (1.91)	10 (1.45)	15 (.35)	126 (23.3)

H_0: There is no relationship between Annual Usage Rate and Item Category.

H_a: There is a relationship between Annual Usage Rate and Item Category.

$\alpha = .10$

$df = (r-1)(c-1) = 12$

Critical value of χ^2 using χ^2 distribution = 18.5

Decision Rule: If the computed χ^2 is greater than the critical value, H_0 can be rejected.

Therefore, since 23.3419 > 18.5, H_0 can be rejected.

The preceding test has provided statistical evidence that there is a relationship between Annual Usage Rate and Item Category. As can be observed from the contingency table (Table 4) Categories one (Communication, Detection and Coherent Radiation Equipment) and two (Hardware and Abrasives) made the largest contributions to chi-square (7.51 and 6.77 respectively). Category three (Aircraft and Airframe Structural Components) made the smallest contribution to chi-square (.22).

Analysis of Classification Usage Rates

The previous analysis indicated that there was a relationship between Annual Usage Rate and Item Category. It was felt that a ranking of the item classifications (based on the first two digits of the Federal Stock Number) according to Usage Rate would be useful in developing general guidelines which could be used to assist Air Force

managers in their determination of whether to purchase reprocurement data.

In developing such a ranking the first step was to rank all 126 items included in the random sample according to each item's Annual Usage Rate (from highest to lowest). Following this, the median rank for each item classification was determined. The results of this analysis are shown in Table 5. This analysis indicated the general importance of various classifications of items in terms of Annual Usage Rates.

Summary

This chapter presented the results of the C-130 case study used for this research. Following the data collection process, three relationships were examined:

1. The relationship between Annual Usage Rate and Price Per Item.

2. The relationship between Annual Usage Rate and AMOP.

3. The relationship between Annual Usage Rate and Item Category.

The Spearman Rank Correlation Coefficient was used in examining the relationship between Annual Usage Rate and Price Per Item. This analysis provided statistical evidence that lower priced items have higher usage rate than higher priced items.

TABLE 5

RANKING OF ITEM CLASSIFICATIONS BY USAGE RATE

Median Rank	Classification	Description
32	53	Hardware & Abrasives
49	28/29	Engines, Turbines & Components, and Engine Accessories
52	16	Aircraft Components & Accessories
62	15	Aircraft & Airframe Structural Components
70	66	Instruments & Laboratory Equipment
82	58	Communications, Detection & Coherent Radiation Equipment

The Kendall Rank Correlation Coefficient was used in examining the relationship between Annual Usage Rate and AMOP. This analysis provided statistical evidence that the larger the quantity of an item that has been purchased, the more likely it is that the purchase was made through competitive means.

The Contingency Coefficient was used in examining the relationship between Annual Usage Rate and Item Category. This analysis provided statistical evidence that there is a relationship between Annual Usage Rate and Item Category.

Finally, the researchers conducted a ranking of item classifications according to Annual Usage Rates. It was felt that this ranking was needed to identify item classifications experiencing relatively high Annual Usage Rates. This ranking provided an indication of those classifications of items for which the ownership of reprocurement data would be the most economically beneficial. This information would be useful to Air Force managers in determining whether to purchase reprocurement data on various classifications of items.

CHAPTER IV

SURVEY QUESTIONNAIRE DATA COLLECTION AND ANALYSIS

Overview

This chapter describes the data collection and analysis used for the survey questionnaire. The purpose of the survey questionnaire was to identify and assess the importance of various factors used by Engineering Data Personnel in their determination of whether to purchase reprocurement data. The researchers felt this information would be useful in describing the guidelines currently being used by Air Force managers in making reprocurement data buying decisions.

Factor analysis was used to identify the underlying pattern of relationships among the questionnaire responses. The technique of factor analysis was chosen primarily because of its data reduction capability.

Question 26, which asked the respondents to rank seven criteria for purchasing reprocurement data from most important to least important, was not included in the factor analysis. The Kendall Coefficient of Concordance (W) was most appropriate to analyze the responses to this question. The information uncovered through the analysis of the survey questionnaire was combined with information

revealed through the case analysis (described in the preceding chapter) in developing general guidelines to assist in making reprocurement data buying decisions.

Survey Administration

Of the thirty-six surveys distributed, thirty-one (86.11 percent) were returned. Four of the five individuals not responding to the questionnaire were assigned to the same Air Logistics Center. These four individuals did not complete the questionnaire due to their belief that the questionnaire was biased (28). The reason for the fifth individual's failure to return the questionnaire is unknown.

Factor Analysis of Twenty Questions

Questions six through twenty-five were analyzed with the assistance of factor analysis. Questions one through four requested only demographic data, while question five was eliminated from the analysis due to the large proportion of respondents who marked more than one response.

The three major steps in conducting a factor analysis are:

1. The preparation of the correlation matrix.
2. The extraction of the initial factors and the exploration of the possibility of data reduction.
3. The search for simple and interpretable factors (11:469).

The standard SPSS factor analysis computer program was used in conducting this analysis.

Number of Factors

An initial computer product provided the eigenvalues and respective variances shown in Table 6.

Following the construction of the table of eigenvalues, the Kaiser Criterion and the Cattell Scree Test were used to determine the number of factors which should be retained in the analysis. The Kaiser Criterion states "that only factors with factor contributions (eigenvalues) of 1.0 or greater should be retained in a factor analysis [27:87]." The application of this rule limited the number of potential factors in future analyses to eight.

The number of factors to be retained was further reduced by using the Cattell Scree Test. Figure 2 shows the graph that was constructed for the Scree Test. The graph plots contribution in percent of variance against factors in order of extraction. The Scree Test was performed by defining the scree, which is a point at which the curve becomes nearly horizontal. "All factors to the left of the point are real factors; those to the right are error or residual factors [27:88]."

As shown in Figure 2, the curve becomes nearly horizontal at Factor 4 with the three factors to the left being real factors and the remaining factors being error

TABLE 6

EIGENVALUES AND EXPLAINED VARIANCE FROM THE INITIAL CORRELATION MATRIX

Factor	Eigenvalue	Total Percentage of Variance Explained	Cumulative Percentage
1	4.26389	21.3	21.3
2	2.92990	14.6	36.0
3	2.35610	11.8	47.7
4	1.92873	9.6	57.4
5	1.59541	8.0	65.4
6	1.32492	6.6	72.0
7	1.10636	5.5	77.5
8 Kaiser Cutoff	1.01652	5.1	82.6
9	0.83157	4.2	86.8
10	0.55410	2.8	89.5
11	0.38986	1.9	91.5
12	0.34993	1.7	93.2
13	0.31497	1.6	94.8
14	0.28813	1.4	96.3
15	0.22983	1.1	97.4
16	0.16472	0.8	98.2
17	0.14084	0.7	98.9
18	0.10214	0.5	99.4
19	0.06748	0.3	99.8
20	0.04458	0.2	100.0

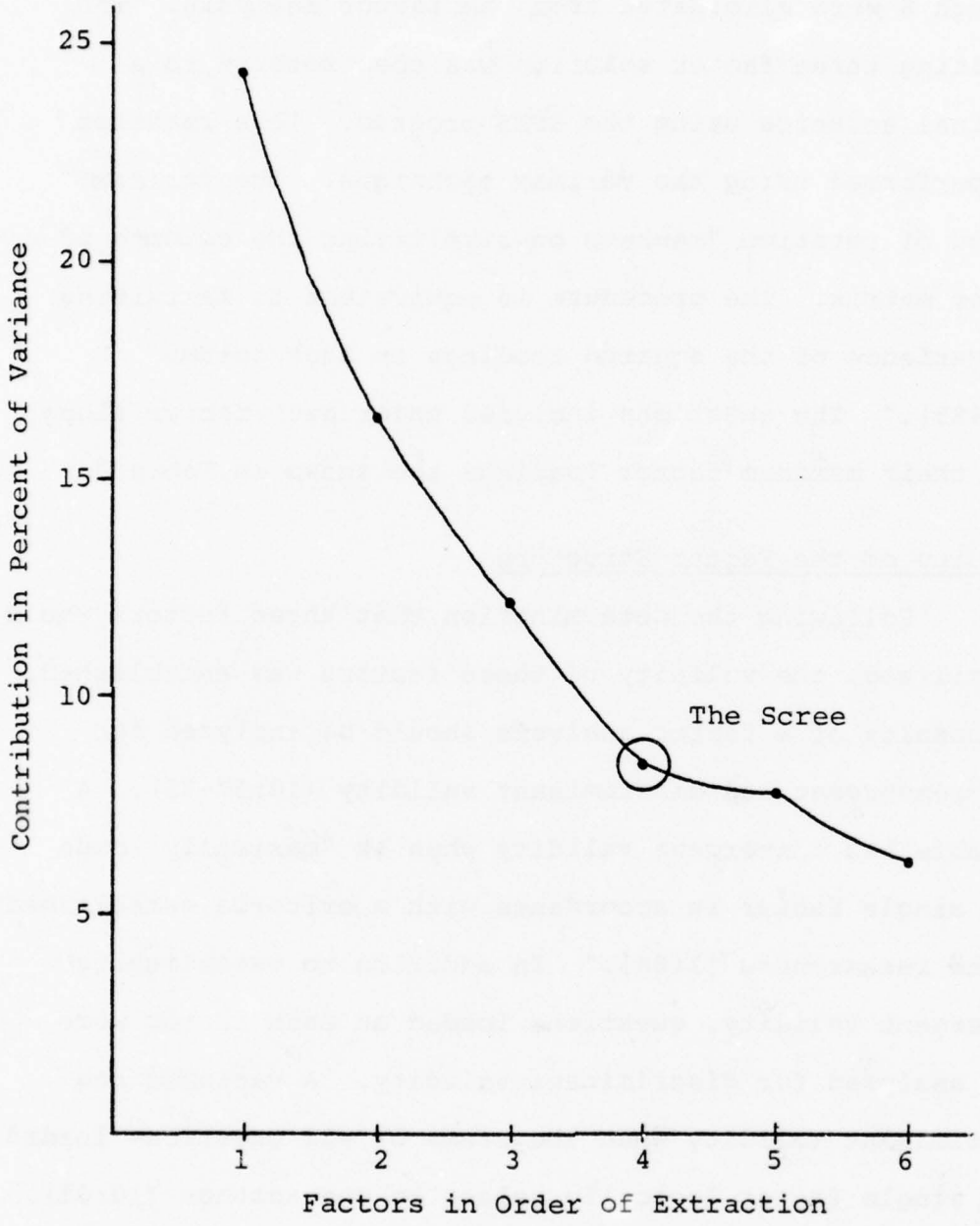


Fig. 2. The Scree Test

or residual factors. As a result of this test, Factors 4 through 8 were eliminated from the factor analysis. The resulting three factor solution was then rotated to a terminal solution using the SPSS program. This rotation was performed using the varimax technique. The varimax method of rotation "centers on simplifying the columns of a factor matrix. The procedure is equivalent to maximizing the variance of the squared loadings in each column [11:485]." The questions included under each factor along with their maximum factor loadings are shown in Table 7.

Validity of the Factor Structure

Following the determination that three factors would be utilized, the validity of these factors was established. The results of a factor analysis should be analyzed for both convergent and discriminant validity (10:37-85). A variable has convergent validity when it "maximally loads on a single factor in accordance with a criteria established by the researchers [1:86]." In addition to establishing convergent validity, questions loaded on each factor were also analyzed for discriminant validity. A variable has discriminant validity when the stems of all questions loaded on a single factor logically relate to one another (10:61).

For this research, convergent and discriminant validity were established by eliminating inappropriate questions. In establishing convergent validity questions not

TABLE 7

QUESTIONS BENEATH EACH FACTOR--THREE FACTORS;
TWENTY QUESTIONS

Factor Loadings		Questions
		Factor 1
.91808	7.	Reprocurement data is useful in obtaining alternative sources for follow-on procurements.
.76572	17.	The use of reprocurement data has resulted in savings to the United States Air Force.
.68774	*25.	The use of reprocurement data is about the only way to purchase replenishment items competitively.
-.66030	16	The Armed Services Procurement Regulation (ASPR) should be revised to reflect less emphasis on competition in government purchasing.
.55566	6.	Generally, reprocurement data should be purchased.
		Factor 2
.71999	14.	Present Air Force guidelines are sufficient to determine if reprocurement data should be purchased.
.64522	21.	The United States Air Force takes sufficient steps to insure the quality of reprocurement data.
.64415	15.	Engineering data personnel employ a standard procedure in determining whether to purchase reprocurement data.

*These questions were prefaced by: How significant are each of the following items (questions 22-25) in deciding whether to buy reprocurement data?

TABLE 7--Continued

Factor Loadings		Questions
-.61625	8.	In general, reprocurement data should be purchased for simple (uncomplicated) items (e.g., safety belts, tires).
-.57273	18.	In general, reprocurement data should be purchased if the annual cost of procuring the item exceeds:
.53492	*22.	ASPR emphasis on competitive buying.
-.36237	9.	In general, reprocurement data should be purchased for electronic equipment components (e.g., resistors, switches, headsets).
-.30431	12.	In general, reprocurement data should be purchased for hardware items (e.g., nuts, bolts, fastening devices).
.27807	*24.	The reputation (name) of the contractor.
-.15096	19.	In general, how long should the projected inventory life be for an item for reprocurement data to be purchased?
	Factor 3	
.96931	10.	In general, reprocurement data should be purchased for engine accessories (e.g., engine fuel system components, engine cooling system components).
.73054	11.	In general, reprocurement data should be purchased for pumps (e.g., power and hand pumps, vacuum pumps).
.68141	13.	In general, reprocurement data should be purchased for aircraft components (e.g., aircraft propellors, aircraft landing gear components).

TABLE 7--Continued

Factor Loadings		Questions
.22124	20.	On what percentage of the items purchased by the Air Force do you feel reprocurement data is also purchased?
.13855	*23.	The possibility that the original supplier of an item might go out of business.

complying with one or more of the following criteria were eliminated:

1. The highest factor loading for a question must be at least .4.

2. The communality must be at least .2.

3. Two factor loadings for a question must not be above .4 (1:88).

The questions that were eliminated in accordance with the preceding rules for the establishment of convergent validity are shown in Table 5. As can be seen from the table, the six questions eliminated all failed to meet both of the first two criteria. No questions were deleted due to a failure to meet the third criterion.

Having established convergent validity, the next step was the establishment of discriminant validity. In analyzing the question loadings under the three-factor solution, meaningful factor patterns emerged. Questions 6, 7, 16, 17 and 25, loaded on Factor 1, pertained to the usefulness of reprocurement data. With the exception of question 8, questions 14, 15, 18, 21 and 22, loaded on Factor 2, dealt with the government policies and procedures regarding the purchase of reprocurement data. The researchers felt that question 8 (In general, reprocurement data should be purchased for simple (uncomplicated) items (e.g., safety belts, tires)) was inappropriately loaded on Factor 2 and therefore was eliminated from the analysis. Questions

TABLE 8

QUESTIONS DELETED USING FACTOR LOADING AND COMMUNALITY RULES

Question	Factor Loading	Communality (Varimax)
9	-.36237	.17094
12	-.30431	.14253
19	-.15096	.03865
20	-.22124	.07459
23	.13855	.03685
24	.03814	.07970

Question

9. In general, reprocurement data should be purchased for electronic equipment components (e.g., resistors, switches, headsets).

12. In general, reprocurement data should be purchased for hardware items (e.g., nuts, bolts, fastening devices).

19. In general, how long should the projected inventory life be for an item for reprocurement data to be purchased?

20. On what percentage of the items purchased by the Air Force do you feel reprocurement data is also purchased?

How significant are each of the following items in deciding whether to buy reprocurement data?

23. The possibility that the original supplier of an item might go out of business.

24. The reputation (name) of the contractor.

10, 11 and 12, loaded on Factor 3, were concerned with the usefulness of reprocurement data in its applicability to mechanical items. The questions remaining in the terminal solution are shown in Table 9.

Usefulness of and Government Policy Toward Reprocurement Data

The factor analysis reduced the data obtained from the survey questionnaire into three factors. As a result, it was decided to report the results of this analysis in terms of these three factors.

In order to draw the desired distinction between the respondents' agreement or disagreement with the questions under any given factor, it was decided to report the data in a format which would preserve the characteristics of the underlying data. To accomplish this, the most appropriate method would be to provide histograms along with measures of central tendency for the questions contained in each factor. Such a reporting scheme has merit if there is a high correlation "between the average scores and the factor index scores for each factor [1:94]."

The method used in reporting the results of this analysis required the computation of the average factor scores and factor index scores. The average factor scores were computed by "summing each respondent's answers to the questions under each factor and dividing by the number of question responses included in the factor [1:164]." For

TABLE 9

QUESTIONS BENEATH EACH FACTOR--TERMINAL SOLUTION

Factor Loadings		Questions
		Factor 1: Usefulness
.91808	7.	Generally, reprocurement data should be purchased.
.76572	17.	The use of reprocurement data has resulted in savings to the United States Air Force.
.68774	*25.	The use of reprocurement data is about the only way to purchase replenishment items competitively.
-.66030	16.	The Armed Services Procurement Regulation (ASPR) should be revised to reflect less emphasis on competition in government purchasing.
.55566	6.	Generally, reprocurement data should be purchased.
		Factor 2: Policies and Procedures
.71999	14.	Present Air Force guidelines are sufficient to determine if reprocurement data should be purchased.
.64522	21.	The United States Air Force takes sufficient steps to insure the quality of reprocurement data.
.64415	15.	Engineering data personnel employ a standard procedure in determining whether to purchase reprocurement data.
-.57273	18.	In general, reprocurement data should be purchased if the annual cost of procuring the item exceeds:

*These questions were prefaced by: How significant are each of the following items (questions 22-25) in deciding whether to buy reprocurement data?

TABLE 9--Continued

Factor Loadings	Questions
.53492	*22. ASPR emphasis on competitive buying.
	Factor 3: Applicability to Mechanical Items
.96931	10. In general, reprocurement data should be purchased for engine accessories (e.g., engine fuel system components, engine cooling system components).
.73054	11. In general, reprocurement data should be purchased for pumps (e.g., power and hand pumps, vacuum pumps).
.68141	13. In general, reprocurement data should be purchased for aircraft components (e.g., aircraft propellors, aircraft landing gear components).

example, if a respondent answered questions 10, 11 and 13 with values of 1, 3, and 2, respectively, the average factor score for Factor 3 would be computed as:

$$\frac{1 + 3 + 2}{3} = 2.0$$

The factor score coefficients provided by the SPSS factor analysis program were utilized to compute factor index scores for each respondent. These factor score coefficients are shown in Table 10.

The following formula was used in calculating the factor index scores:

$$f_i = f_{sc_{1i}} z_1 + f_{sc_{2i}} z_2 + \ldots + f_{sc_{ni}} z_n$$

where,

f_i = the factor index score,

$f_{sc_{ji}}$ = the factor-score coefficient for variable j on factor i, and

z_j = the standardized value on variable j (11:489).

The standardized variable values (z_j) were computed by:

$$z_j = (Q_N - \bar{Q}_N)/\sigma_{Q_N}$$

where,

Q_N = the respondent's answer to the given question,

TABLE 10

FACTOR SCORE COEFFICIENTS

	Factor 1	Factor 2	Factor 2
Q06	-0.43121	0.08517	0.17227
Q07	1.01820	-0.26733	0.05374
Q10	-0.30337	-0.20314	1.41534
Q11	-0.05126	0.06037	-0.14696
Q13	0.23723	0.02135	-0.32799
Q14	0.07434	0.28009	0.05199
Q15	0.26397	0.19210	-0.24817
Q16	0.11389	-0.02440	-0.37413
Q17	0.46279	-0.05648	-0.32742
Q18	0.18146	-0.16295	0.01468
Q21	-0.34074	0.22271	0.33573
Q22	0.16357	0.10056	0.05518
Q25	-0.22617	0.13959	0.06220

$\bar{Q}_N$ = the mean of all respondent's answers to the given question, and

σ_{Q_N} = the standard deviation about the mean of all respondent's answers to the questions (1:160-161).

The validity of the reporting scheme was established by conducting a correlation analysis between the factor index scores and the average scores for each factor. The results of this correlation analysis are shown in Table 11. The resulting correlation coefficients indicated that average scores and factor index scores were strongly related. As a result, it was decided to report the data in terms of average scores.

TABLE 11

CORRELATION OF FACTOR INDEX SCORES WITH AVERAGE SCORES

	Correlation Coefficients	Percent of Confidence*
Factor 1	.7456	99.9%
Factor 2	.7751	99.9%
Factor 3	.8401	99.9%

*Using the Pearson Product-moment Correlation Coefficient test, the correlation coefficients proved to be significantly different from zero at the 99.9 percent confidence level.

Factor 1: Usefulness

The histogram of the average scores in Factor 1 is shown in Figure 3. The average scores intervals are shown

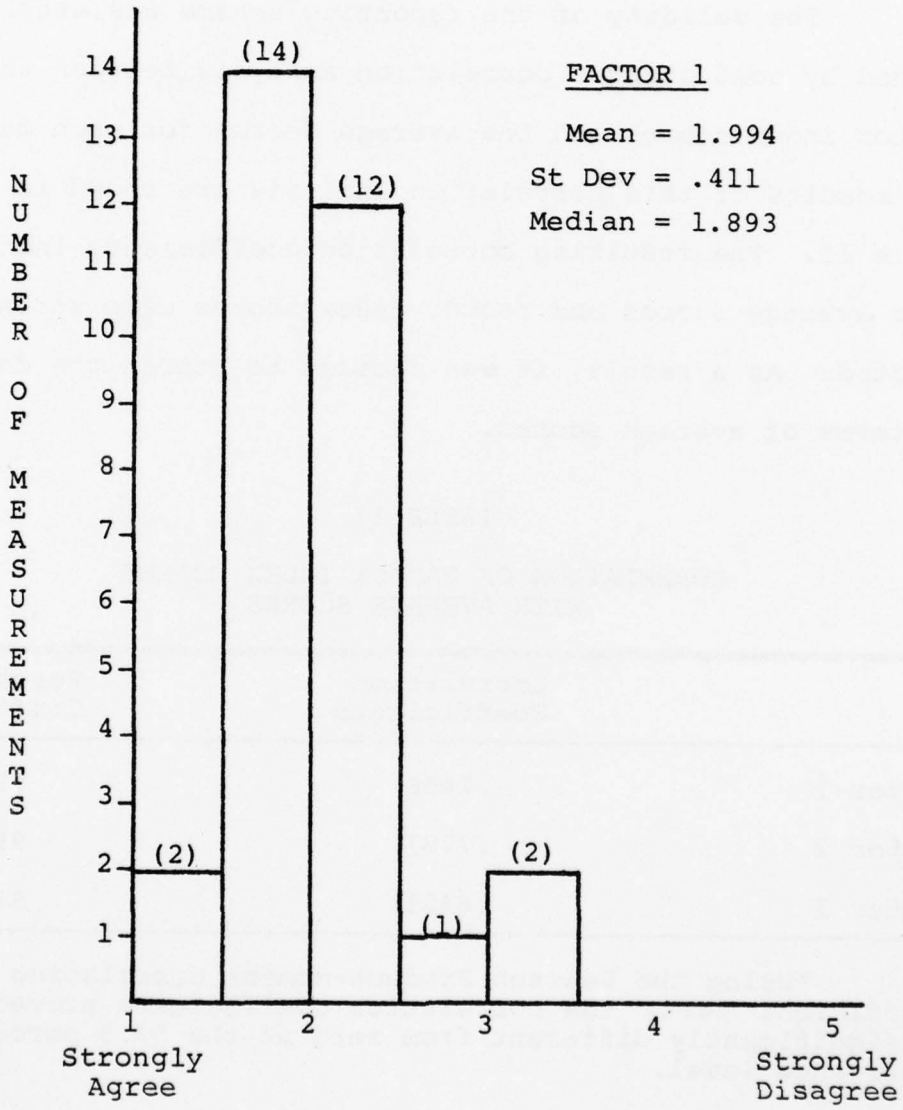


Fig. 3. Histogram of Factor 1: Usefulness

on the horizontal axis and the number of scores included in each interval is shown on the vertical axis. The number of average scores included in each interval is also expressed numerically by the number enclosed in parenthesis at the top of each bar of the histogram.

As can be seen from Figure 3, the vast majority of respondents (93.5%) thought that reprocurement data was useful. The mean score was 1.994. The coefficient of skewness was computed as 1.638.

Factor 2: Policies and Procedures

The histogram of the average scores in Factor 2 is shown in Figure 4. This histogram illustrates that responses were well balanced around the midpoint (15 below 3.0 and 16 above 3.0). The mean score was 2.948 and the coefficient of skewness was .245. These average scores indicated a large amount of disagreement as to whether present government policies regarding the purchase of reprocurement data are adequate.

Factor 3: Applicability to Mechanical Items

Figure 5 shows that most of the respondents (80.6 percent) felt that reprocurement data is useful in purchasing mechanical items. The mean score was 1.753 and the coefficient of skewness was 1.211.

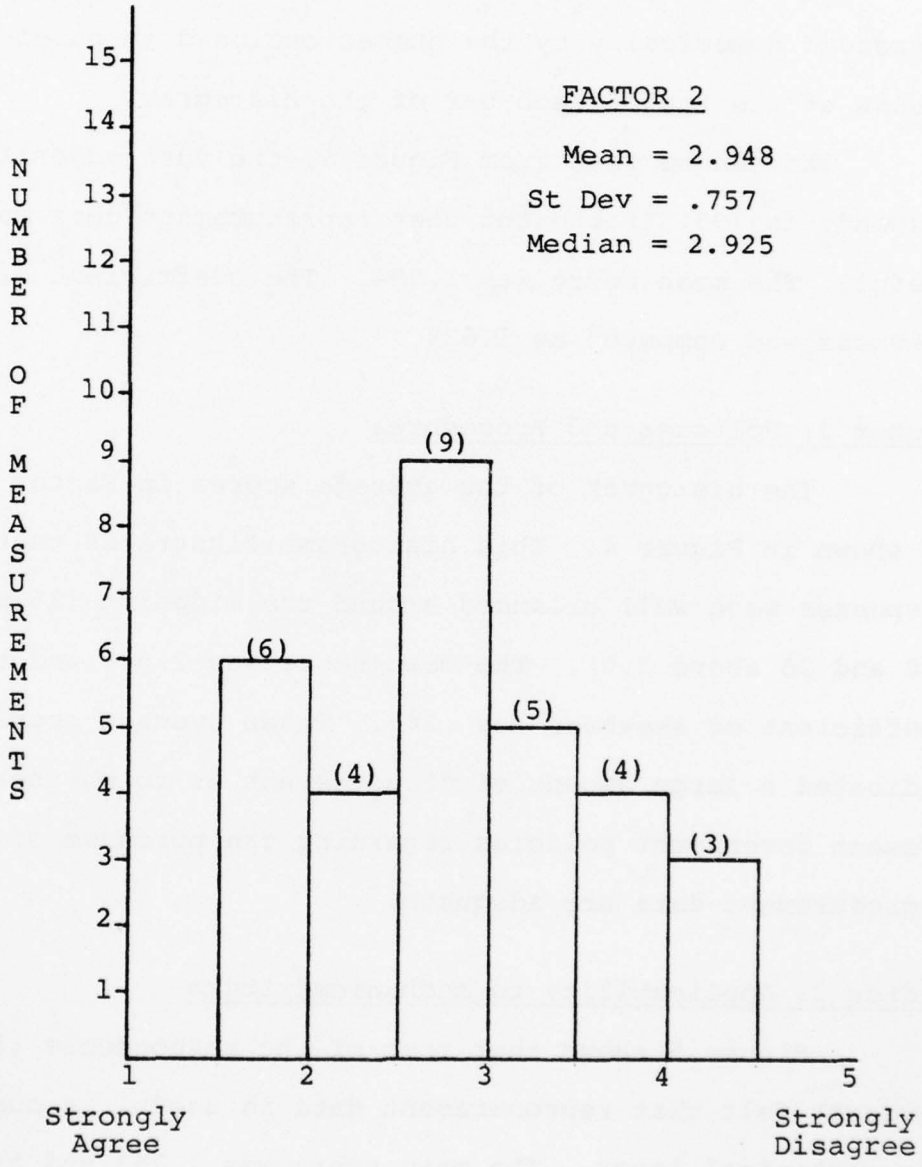


Fig. 4. Histogram of Factor 2: Policies and Procedures

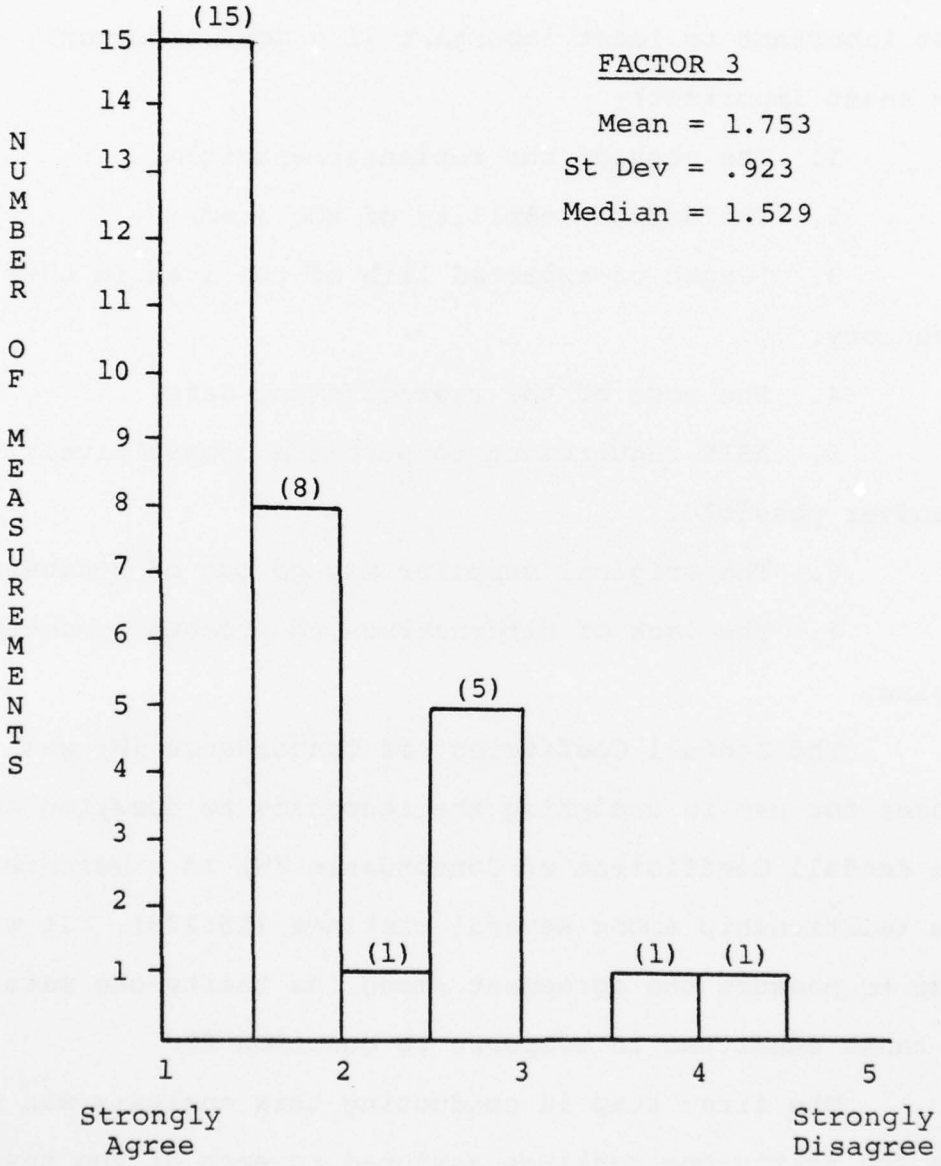


Fig. 5. Histogram of Factor 3: Applicability to Mechanical Items

Application of the Kendall Coefficient of Concordance (W) to Question 26

Question 26 asked the respondents to rank the following seven criteria for purchasing reprocurement data from most important to least important (1 = most important, 7 = least important):

1. The cost of the replenishment item.
2. The design stability of the item.
3. Length of expected life of the item in the inventory.
4. The cost of the reprocurement data.
5. ASPR requirement to purchase competitively whenever possible.
6. The original supplier may go out of business.
7. The lack of alternatives to promote competitive buying.

The Kendall Coefficient of Concordance (W) was chosen for use in analyzing the responses to Question 26. The Kendall Coefficient of Concordance (W) is a measure of the relationship among several rankings (15:229). It was used to measure the agreement among the thirty-one sets of ranks submitted in response to Question 26.

The first step in conducting this analysis was to sum the thirty-one rankings assigned to each of the seven factors. This sum of ranks (R_j) was then divided by the number of respondents (31) to obtain the mean value of each

R_j. The Kendall Coefficient of Concordance was then computed using the following formula:

$$W = \frac{s}{\frac{1}{12} k^2 (N^3-N)}$$

where,

W = Kendall Coefficient of Concordance,

s = sum of squares of the observed deviations from the mean of R_j, that is

$$s = \Sigma (R_j - \frac{R_j}{N})^2 ,$$

N = number of factors ranked, and

k = number of sets of rankings.

The computation of W is shown next.

$$W = \frac{s}{\frac{1}{12} k^2 (N^3-N)} = \frac{6202}{(\frac{1}{12})(31)^2((7)^3-7)}$$

$$W = .23$$

According to Gibbons, the following formula can be utilized in testing the significance of the Kendall Coefficient of Concordance (8:423).

$$Q = \frac{12s}{kN(N+1)}$$

where,

Q = the χ^2 test statistic,

s = sum of squares of the observed deviations from the mean of R_j,

N = number of factors ranked, and

k = number of sets of rankings.

The significance of the computed W (.23) was tested at a significance level of .10 (α=.10) which was set arbitrarily by the researchers. The significance test follows.

H_0: There is not agreement among the respondents' rankings.

H_a: There is agreement among the respondents' rankings.

Degrees of Freedom (df) = N-1=6.

$$Q = \frac{(12)(6202)}{(31)(7)(7+1)}$$

$$Q = 42.87$$

Critical value of Q using χ^2 distribution = 10.6.

Decision rule: If the computed value of Q is greater than the critical value, H_0 can be rejected.

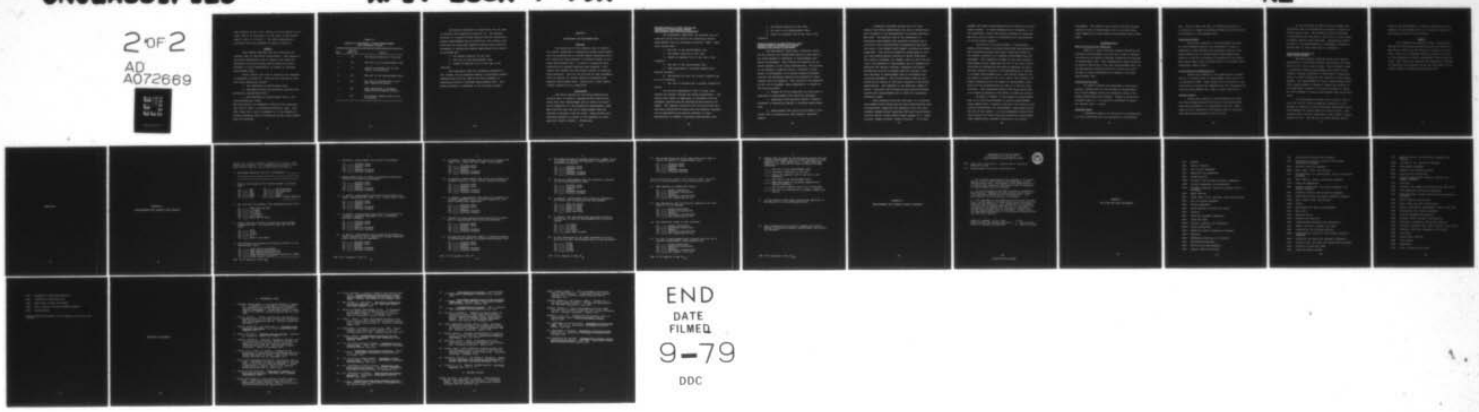
Therefore, since 42.86 > 10.6, H_0 can be rejected.

Although the preceding test provided statistical evidence that there was agreement among the respondents' rankings, it was felt that a single ranking summarizing these results was also needed. "Kendall suggests that the

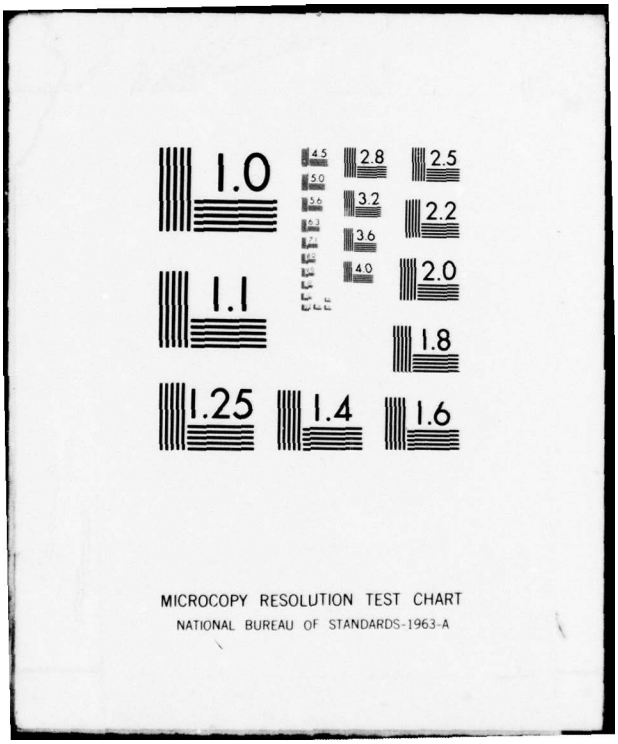
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3.6
4.0
4.5
5.0
5.6
6.3
7.1
MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS-1963-A

best estimate of the 'true' ranking of the N objects is provided, when W is significant, by the order of the various sums of ranks, R_j [15:238]." The ranking developed in accordance with this procedure is shown in Table 12.

Summary

This chapter described the data collection and analysis used for the survey questionnaire. The purpose of the survey questionnaire was to identify and assess the importance of various factors used by Engineering Data Personnel in their determination of whether to purchase reprocurement data.

Factor analysis was used in analyzing the responses to questions 6 through 25. This analysis reduced the data into three underlying factors:

1. The usefulness of reprocurement data.
2. Government policy and procedures regarding the purchase of reprocurement data.
3. The usefulness of reprocurement data in purchasing mechanical items.

The vast majority of respondents indicated that reprocurement data is useful in purchasing mechanical items. However, there was a lack of agreement as to the adequacy of present procedures used in determining whether reprocurement data are purchased.

TABLE 12

RANKING OF IMPORTANCE OF SEVEN REPROCUREMENT DATA PURCHASING FACTORS

Rank	Sum of Ranks (R_j)	Factor
1	90	The design stability of the item
2	92	The cost of the replenishment item
3	97	Length of expected life of the item in the inventory
4	126	The cost of the reprocurement data
5	140	The lack of alternatives to promote competitive buying
6	151	ASPR requirement to purchase competitively whenever possible
7	172	The original supplier may go out of business

The Kendall Coefficient of Concordance (W) was used in analyzing the responses to Question 26. The analysis resulted in a ranking of seven factors used for determining whether reprocurement data are purchased. This ranking indicated that the three most important factors which should be considered in determining whether reprocurement data should be purchased are:

1. The design stability of the item.
2. The cost of the replenishment item.
3. Length of expected life of the item in the inventory.

The researchers used the information presented in this chapter and the preceding chapter in developing general guidance which could be used by Air Force managers in determining whether to purchase reprocurement data. This general guidance is presented in the following chapter.

CHAPTER V

CONCLUSIONS AND RECOMMENDATIONS

Overview

The objectives of this research were to identify the factors considered in determining whether reprocurement data are purchased and to provide general guidelines which will assist Air Force managers in deciding whether to purchase reprocurement data. In order to accomplish these objectives, two research questions were answered. This chapter will present the conclusions reached in answering these questions. This will be followed by some recommendations to improve the current system of purchasing and managing reprocurement data. Additionally, areas needing further research will be identified.

Conclusions

The factor analysis of the survey questionnaire revealed that, in general, Engineering Data Section personnel feel that reprocurement data is useful for facilitating competition in the purchase of replenishment items. They also feel that the use of reprocurement data has resulted in savings to the Air Force. These beliefs were uncovered through an analysis of the responses to those questions loaded on Factor 1 (Usefulness).

Research Question 1--What factors are considered in determining whether reprocurement data should be purchased?

The researchers identified, and assessed the consideration given seven factors for determining whether reprocurement data are purchased on specific items. These seven factors were:

1. The cost of the replenishment item.

2. The design stability of the item.

3. Length of expected life of the item in the inventory.

4. The cost of the reprocurement data.

5. ASPR requirement to purchase competitively whenever possible.

6. The possibility that the original supplier may go out of business.

7. The lack of alternatives to promote competitive buying.

The relative importance of each of these seven factors was analyzed through the survey questionnaire. The factors were ranked in importance in accordance with the responses received from the Engineering Data Section personnel. This ranking resulted in the following three factors being identified as being given the greatest consideration by Engineering Data Section personnel in their determination of whether to purchase reprocurement data:

1. The design stability of the item.

2. The cost of the replenishment item.

3. Length of expected life of the item in the inventory.

Research Question 2--What decision rules should be used to determine if reprocurement data should be purchased?

The researchers, during their literature review, did not discover any standardized decision rules used by Air Force managers to determine if reprocurement data should be purchased. This finding was supported by the factor analysis of the survey questionnaire. The analysis of the questions loaded on Factor 2 indicated a large amount of disagreement as to whether present government policies and procedures regarding the purchase of reprocurement data are adequate. This conclusion was supported by the lack of agreement among respondents' in regard to the following ideas:

1. Present Air Force guidelines are sufficient to determine if reprocurement data should be purchased.

2. Engineering Data personnel employ a standard procedure in determining whether to purchase reprocurement data.

3. Reprocurement data should be purchased if the annual cost of purchasing an item exceeds a specified amount.

Information uncovered through the C-130 case analysis and survey questionnaire was used in establishing basic guidance in the determination to purchase reprocurement data. The approach used by the researchers in developing reprocurement data purchasing guidance was to prioritize Item Classifications (as defined by the first two digits of the Federal Stock Number) according to Annual Usage Rate. This priority system was established by ranking Item Classifications according to Annual Usage Rate. This ranking indicated, for example, that for the C-130 aircraft, the ownership of reprocurement data on Hardware and Abrasives and Engines, Turbines, Components and Engine Accessories would be of greater potential economic value than ownership of reprocurement data on Instruments and Laboratory Equipment. This prioritization idea was supported by the results of the factor analysis of the survey questionnaire. The responses to the questions loaded on Factor 3 indicated that Engineering Data Section personnel believe that reprocurement data is useful for purchasing mechanical items.

This procedure would only have merit if a relationship between Annual Usage Rate and Item Classification could be established, supporting the assumption that this relationship (between Annual Usage Rate and Item Classification) would be similar across similar weapon systems (i.e., cargo aircraft, bomber aircraft, fighter aircraft). It is also

assumed that these relationships would be similar for future weapon systems. If these assumptions are validated, it is the researchers' belief that future purchases of reprocurement data could be based on established past relationships of similar weapon systems.

During the C-130 case analysis, a relationship between Item Category and Annual Usage Rate was established. The researchers believe that Annual Usage Rate should be the primary criterion as to whether reprocurement data are purchased. This assertion is based on the close relationship between Annual Usage Rate and two of the three factors identified by Engineering Data Section personnel as being the most important factors in the determination of whether to purchase reprocurement data. Both design stability and the length of expected life of an item in the inventory are primary determinants of the number of replenishment items which will be purchased while an item is in the Air Force inventory. The researchers believe that Annual Usage Rate is an objective measure of the effect of these two factors.

As noted in Chapter I, the purpose of reprocurement data is to allow the government to procure replenishment items competitively, instead of having to rely solely on the original manufacturer for replenishment items needed during the life of the system. It is the government's belief that cost savings will result from the purchase of replenishment items competitively instead of relying on sole source

procurement. The greatest cost savings would be realized through the use of reprocurement data to purchase those items competitively which exhibit the greatest Annual Usage Rates.

Recommendations

Need for Policies and Guidelines

There is a lack of written guidance concerning the purchase of reprocurement data and thus a need to document firm policies and specific guidance concerning the purchase of reprocurement data. This documentation should establish an official definition of the term "reprocurement data" and include specific guidelines which will assist Air Force managers in their determination of whether to purchase reprocurement data.

Contracting for Data

In order to enhance the government's negotiating posture, negotiations for the purchase of reprocurement data should commence during the conceptual phase of the weapon system acquisition process. Competing contractors' proposals regarding data should be considered in making the contract award decision.

Ownership Costs

A procedure needs to be instituted for accumulating all costs associated with the ownership of reprocurement

data. Since no such cost data is currently available, it is difficult to assess the economic benefits derived through the ownership of reprocurement data.

Proprietary Rights

During this research, it was discovered that some Air Force managers believe that contractors' claims of proprietary rights prevents the government from utilizing reprocurement data to purchase many items competitively. There is a need for an analysis to determine if the government should make a more concerted effort to challenge these proprietary rights claims.

Centralization of Responsibility

During this research it was observed that although AFLC is the primary user of reprocurement data, much of it is purchased by AFSC. There needs to be an analysis of the feasibility of placing the responsibility for purchasing and managing reprocurement data under a single organization.

Quality Control

During this research it was discovered that some Air Force managers believe that much of the reprocurement data being purchased is of questionable quality. There needs to be an analysis of the quality level of reprocurement data being purchased by the Air Force.

It was the belief of some Air Force managers that contractors were not provided with sufficient incentive to furnish quality data. Such incentive could be provided by considering each contractor's past record in this regard in making contract award decisions. Consideration should be given to the establishment of a Management Information System (MIS) to record this type of information.

Case Analysis Research on Other Weapon Systems

The case analysis conducted during this research established a relationship between Item Category and Usage Rate for the C-130 aircraft system. This provided a means of determining whether reprocurement data should be purchased on various categories of items based on Usage Rate. There is a need to replicate this research on other weapon systems. The establishment of similar relationships within other weapon systems is needed to support the validity of the researchers' approach to providing guidance to assist Air Force managers in making reprocurement data buying decisions.

A case analysis of another cargo aircraft (such as the C-141 or C-5) would be especially beneficial in an attempt to discover if the relationships established during this research are similar among all cargo aircraft. This research should also be replicated on other types of weapon systems as well. The end goal of these research efforts

would be the establishment of specific guidelines for the purchase of reprocurement data on all types of weapon systems entering the Air Force inventory.

Summary

This research has pointed out that, although most Engineering Data Section personnel believe that reprocurement data is useful and has resulted in savings to the Air Force, there is no documented specific guidance to assist Air Force managers in making reprocurement data buying decisions. This thesis has presented the researchers' approach to developing such guidance and for the improvement of the overall system of managing reprocurement data.

APPENDICES

APPENDIX A

REPROCUREMENT DATA RESEARCH QUESTIONNAIRE

Please fill in the requested information or place a check beside your response. Your responses may be based on personal opinion and not just authoritative information.

1. My present position title is: (be specific) _____

_____

_____

2. What is your present civil service grade or military rank?

(1) _____	GS7	(6) _____	2nd Lieutenant
(2) _____	GS9	(7) _____	1st Lieutenant
(3) _____	GS11	(8) _____	Captain
(4) _____	GS12	(9) _____	Major
(5) _____	GS13	(10) _____	Other (please specify): _____

3. How long have you worked in the engineering data field?

(1) _____ Less than one year
(2) _____ 1-3 years
(3) _____ 4-6 years
(4) _____ 7-10 years
(5) _____ 11-20 years
(6) _____ More than 20 years

4. Please indicate aircraft for which you have managed engineering data. You may select more than one aircraft.

(1) _____ B-52
(2) _____ C-130
(3) _____ KC-135
(4) _____ F-4
(5) _____ None of the above

5. Who provides your guidance for deciding whether to buy reprocurement data?

(1) _____ Local office procedures
(2) _____ AFLC Regulations/Directives
(3) _____ USAF Regulations/Directives
(4) _____ Armed Services Procurement Regulation (ASPR)
(5) _____ Other (please specify): _____

SCN: 79-74 (expires 31 May 79)

6. Generally, reprocurement data should be purchased.

(1) _____ Strongly agree
(2) _____ Somewhat agree
(3) _____ Neutral
(4) _____ Somewhat disagree
(5) _____ Strongly disagree

7. Reprocurement data is useful in obtaining alternative sources for follow-on procurements.

(1) _____ Strongly agree
(2) _____ Somewhat agree
(3) _____ Neutral
(4) _____ Somewhat disagree
(5) _____ Strongly disagree

8. In general, reprocurement data should be purchased for simple (uncomplicated) items (e.g., safety belts, tires).

(1) _____ Strongly agree
(2) _____ Somewhat agree
(3) _____ Neutral
(4) _____ Somewhat disagree
(5) _____ Strongly disagree

9. In general, reprocurement data should be purchased for electronic equipment components (e.g., resistors, switches, headsets).

(1) _____ Strongly agree
(2) _____ Somewhat agree
(3) _____ Neutral
(4) _____ Somewhat disagree
(5) _____ Strongly disagree

10. In general, reprocurement data should be purchased for engine accessories (e.g., engine fuel system components, engine cooling system components).

(1) _____ Strongly agree
(2) _____ Somewhat agree
(3) _____ Neutral
(4) _____ Somewhat disagree
(5) _____ Strongly disagree

11. In general, reprocurement data should be purchased for pumps (e.g., power and hand pumps, vacuum pumps).

(1) _____ Strongly agree
(2) _____ Somewhat agree
(3) _____ Neutral
(4) _____ Somewhat disagree
(5) _____ Strongly disagree

12. In general, reprocurement data should be purchased for hardware items (e.g., nuts, bolts, fastening devices).

(1) _____ Strongly agree
(2) _____ Somewhat agree
(3) _____ Neutral
(4) _____ Somewhat disagree
(5) _____ Strongly disagree

13. In general, reprocurement data should be purchased for aircraft components (e.g., aircraft propellors, aircraft landing gear components).

(1) _____ Strongly agree
(2) _____ Somewhat agree
(3) _____ Neutral
(4) _____ Somewhat disagree
(5) _____ Strongly disagree

14. Present Air Force guidelines are sufficient to determine if reprocurement data should be purchased.

(1) _____ Strongly agree
(2) _____ Somewhat agree
(3) _____ Neutral
(4) _____ Somewhat disagree
(5) _____ Strongly disagree

15. Engineering data personnel employ a standard procedure in determining whether to purchase reprocurement data.

(1) _____ Strongly agree
(2) _____ Somewhat agree
(3) _____ Neutral
(4) _____ Somewhat disagree
(5) _____ Strongly disagree

16. The Armed Services Procurement Regulation (ASPR) should be revised to reflect less emphasis on competition in government purchasing.

(1) _____ Strongly agree
(2) _____ Somewhat agree
(3) _____ Neutral
(4) _____ Somewhat disagree
(5) _____ Strongly disagree

17. The use of reprocurement data has resulted in savings to the United States Air Force.

(1) _____ Strongly agree
(2) _____ Somewhat agree
(3) _____ Neutral
(4) _____ Somewhat disagree
(5) _____ Strongly disagree

18. In general, reprocurement data should be purchased if the annual cost of procuring the item exceeds:

(1) _____ Less than $1000
(2) _____ $1000 to $2500
(3) _____ $2500 to $4000
(4) _____ $4000 to $5500
(5) _____ More than $5500

19. In general, how long should the projected inventory life be for an item for reprocurement data to be purchased?

(1) _____ 0-2 years
(2) _____ 3-5 years
(3) _____ 6-8 years
(4) _____ 9-10 years
(5) _____ More than 10 years

20. On what percentage of the items purchased by the Air Force do you feel reprocurement data is also purchased?

(1) _____ 0-20%
(2) _____ 21-40%
(3) _____ 41-60%
(4) _____ 61-80%
(5) _____ 80-100%

21. The United States Air Force takes sufficient steps to insure the quality of reprocurement data.

(1) _____ Strongly agree
(2) _____ Somewhat agree
(3) _____ Neutral
(4) _____ Somewhat disagree
(5) _____ Strongly disagree

How significant are each of the following items (questions 22-25) in deciding whether to buy reprocurement data?

22. ASPR emphasis on competitive buying.

(1) _____ Highly significant
(2) _____ Relatively significant
(3) _____ Neutral
(4) _____ Relatively insignificant
(5) _____ Not significant at all

23. The possibility that the original supplier of an item might go out of business.

(1) _____ Highly significant
(2) _____ Relatively significant
(3) _____ Neutral
(4) _____ Relatively insignificant
(5) _____ Not significant at all

24. The reputation (name) of the contractor.

(1) _____ Highly significant
(2) _____ Relatively significant
(3) _____ Neutral
(4) _____ Relatively insignificant
(5) _____ Not significant at all

25. The use of reprocurement data is about the only way to purchase replenishment items competitively.

(1) _____ Highly significant
(2) _____ Relatively significant
(3) _____ Neutral
(4) _____ Relatively insignificant
(5) _____ Not significant at all

26. Please rank all seven of the following criteria for purchasing reprocurement data from most important to least important (1 = most important, 7 = least important). Please do not indicate two items as having the same importance.

_____ The cost of the replenishment item

_____ The design stability of the item

_____ Length of expected life of the item in the inventory

_____ The cost of the reprocurement data

_____ ASPR requirement to purchase competitively whenever possible

_____ The original supplier may go out of business

_____ The lack of alternatives to promote competitive buying

27. In your opinion, what other criteria are important in the decision to buy reprocurement data?

28. What suggestions do you have to improve the current system of determining whether reprocurement data should be purchased?

APPENDIX B

REPROCUREMENT DATA RESEARCH SURVEY COVERSHEET

DEPARTMENT OF THE AIR FORCE
AIR FORCE INSTITUTE OF TECHNOLOGY (ATC)
WRIGHT-PATTERSON AIR FORCE BASE, OHIO 45433

REPLY TO ATTN OF: LSGR (LSSR 7-79A)/Capt R. Johnson/Capt M. Southwick
AUTOVON 78-56569

SUBJECT: Reprocurement Data Survey Questionnaire

TO:

1. The attached questionnaire was prepared by a research team at the Air Force Institute of Technology, Wright-Patterson AFB, Ohio. The purpose of the questionnaire is to acquire data concerning the factors used to determine if reprocurement data is purchased.

2. You are requested to provide an answer or comment for each question. Headquarters USAF Survey Control Number 79-74 has been assigned to this questionnaire. Your participation in this research is voluntary.

3. Your responses to the questions will be held confidential. Please remove this cover sheet before returning the completed questionnaire. Your cooperation in providing this data will be appreciated and will be very beneficial in examining the factors that are used in determining whether reprocurement data is purchased. Please return the completed questionnaire in the attached envelope within one week after receipt.

DONALD R. EDWARDS, Lt Col, USAF
Associate Dean for Graduate Education
School of Systems and Logistics

2 Atch
1. Questionnaire
2. Return Envelope

APPENDIX C

FSC CLASS AND AREA ASSIGNMENTS

10GP	Weapons
11GP	Nuclear ordnance
12GP	Fire control equipment
13GP	Ammunition and explosives
14GP	Guided missiles
15GP*	Aircraft, and airframe structural components
16GP*	Aircraft components and accessories
17GP*	Aircraft launching, landing and ground handling equipment
18GP	Space vehicles
19GP	Ships, small craft, pontoons, and floating docks
20GP	Ship and marine equipment
22GP	Railway equipment
23GP	Motor vehicles, trailers and cycles
24GP	Tractors
25GP	Vehicular equipment components
26GP	Tires and tubes
28GP*	Engines, turbines, and components
29GP*	Engine accessories
30GP*	Mechanical power transmission equipment
31GP*	Bearings
32GP	Woodworking machinery and equipment
34GP	Metalworking machinery
35GP	Service and trade equipment
36GP	Special industry machinery

37GP	Agricultural machinery and equipment
38GP	Construction, mining, excavating and highway maintenance equipment
39GP	Materials handling equipment
40GP*	Rope, cable, chain, and fittings
41GP	Refrigeration, air conditioning, and air circulation equipment
42GP	Fire fighting, rescue, and safety equipment
43GP*	Pumps and compressors
44GP	Furnace, steam plant, and drying equipment, and nuclear reactors
45GP	Plumbing, heating, and sanitation equipment
46GP	Water purification and sewage treatment equipment
47GP*	Pipe, tubing, hose, and fittings
48GP*	Valves
49GP	Maintenance and repair shop equipment
51GP	Hand tools
52GP	Measuring tools
53GP*	Hardware and abrasives
54GP	Prefabricated structures and scaffolding
55GP	Lumber, millwork, plywood, and veneer
56GP	Construction and building materials
58GP*	Communication, detection, and coherent radiation equipment
59GP*	Electrical and electronic equipment components
61GP	Electric wire, and power and distribution equipment
62GP	Lighting fixtures and lamps
63GP	Alarm and signal systems

65GP	Medical, dental, and veterinary equipment and supplies
66GP*	Instruments and laboratory equipment
67GP	Photographic equipment
68GP	Chemicals and chemical products
69GP	Training aids and devices
70GP	General purpose ADPE, software, supplies and support equipment
71GP	Furniture
72GP	Household and commercial furnishing and appliances
73GP	Food preparation and serving equipment
74GP	Office machines, visible record and data processing equipment
75GP	Office supplies and services
76GP	Books, maps, and other publications
77GP	Musical instruments, phonographs, radios, home type
78GP	Recreational and athletic equipment
79GP	Cleaning equipment and supplies
80GP	Brushes, paints, sealers, and adhesives
81GP	Containers, packaging, and packing supplies
83GP	Textiles, leathers, furs, shoe fittings, tents, flags
84GP	Clothing, individual equipment, and insignia
85GP	Toiletries
87GP	Agricultural supplies
88GP	Live animals
89GP	Subsistence
91GP	Fuels, lubricants and waxes

93GP	Nonmetallic fabricated materials
94GP	Nonmetallic crude materials
95GP	Metal bars, sheets, and shapes
96GP	Ores, minerals and their primary products
99GP	Miscellaneous

*These items were selected for the sample of the C-130 case analysis.

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