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## THESIS

TELECOMMUNICATION SYSTEM FOR BACHELOR  
OFFICERS QUARTERS:  
COST-EFFECTIVENESS AND  
LEASE/PURCHASE ANALYSIS

by

James B. Fritz

June 1990

Thesis Advisor: William R. Gates

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Telecommunication System for Bachelor Officers Quarters:  
Cost-effectiveness and Lease/Purchase Analysis

by

James B. Fritz  
Captain, United States Marine Corps  
B.S., Purdue University, 1984

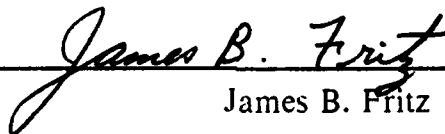
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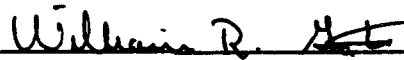
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Author:

  
James B. Fritz

Approved by:



William R. Gates, Thesis Advisor



Myung W. Suh, Second Reader



David R. Whipple, Chairman,  
Department of Administrative Sciences

## ABSTRACT

The purpose of this thesis is to perform a cost-effectiveness analysis on proposals, submitted by vendors, for a telecommunication system. This thesis will be used as a guide in the decision-making process of choosing the most cost-effective system for the Bachelor Officers Quarters of the Naval Postgraduate School. In addition to cost-effectiveness, this study includes a discussion of the analysis criteria, a review of the Statement of Work and an evaluation of the lease/purchase decision.



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## **I. INTRODUCTION**

The Bachelor Officers Quarters (BOQ) of the Naval Postgraduate School (NPS) is located in Herrmann Hall. The BOQ consists of three buildings which are the Main Building (Bldg. 220), the East wing (Bldg. 221) and the West wing (Bldg. 222). A layout of the three buildings can be seen in Figure 1. These three buildings provide 180 rooms for billeting of officers and civilian personnel attending the Naval Postgraduate School or related activities.

Presently, the BOQ has no internal telecommunication system, and as a result, BOQ and NPS base officials established specifications for a new telecommunication system. These specifications were then opened to commercial contractors for bids on the new system. However, the contract was cancelled due to the departure of key NPS personnel involved and the unfortunate death of the individual who developed the specifications and Statement of Work.

### **A. OBJECTIVES**

This thesis will provide a cost-effectiveness analysis to aid in the decision-making process, after a new Request for Proposal (RFP) is submitted to contractors. The main objectives of this study are as follows:

- Develop the analysis criteria.
- Review the Statement of Work.
- Evaluate the vendors' proposals.
- Discuss unpredictable limitation concerns.
- Perform cost-effectiveness and Net Present Value analyses.
- Evaluate the lease/purchase decision.

### **B. BACKGROUND**

As previously mentioned, there is no internal telecommunication means available between residents and guests of the BOQ and front desk personnel. In addition, residents and guests of the BOQ have no means available to contact one another. The lack of an internal communication system presents several prob-

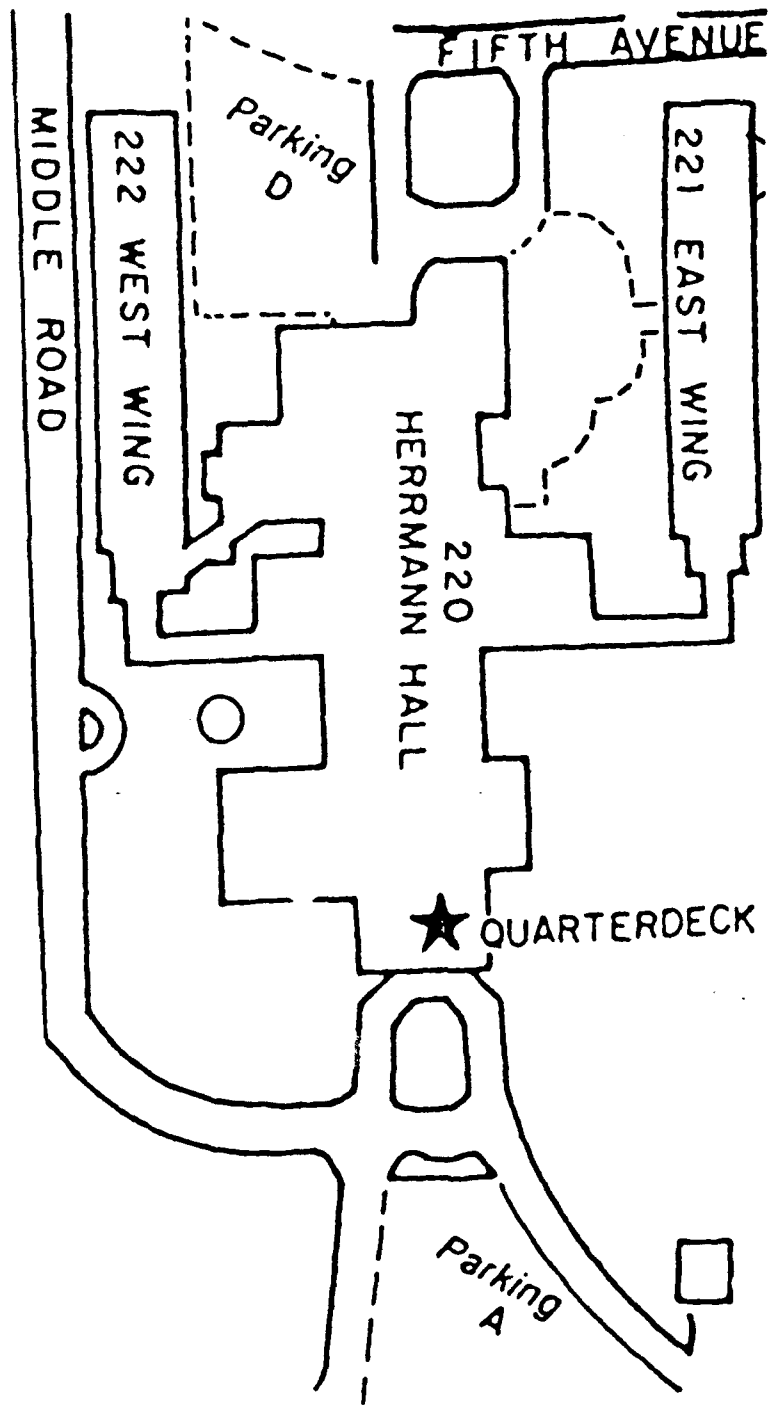


Figure 1. BOQ Layout

lems and results in the inefficient use of front desk personnel. Some of the problems listed below serve as justification for a new telecommunication system and will be explained further in the following paragraphs.

- Front desk personnel hand deliver messages which is very time consuming.
- Delays in contacting residents in emergencies.
- Lost revenue from commercial calls made from VIP suites.
- Temporary additional duty residents are not able to contact parent commands.
- Inability of foreign students to contact their representatives.
- Excessive time spent by staff to track outside calls made from VIP suites.

Because there is no internal telecommunication means between BOQ residents and front desk personnel, long delays exist in contacting residents and delivering messages. Front desk personnel receive all incoming calls to the BOQ, and, in addition, are often asked to deliver messages to the residents. If there is only one person working at the desk, he or she would need to temporarily vacate the BOQ front desk or not be available to deliver any messages until other desk personnel arrived.

This could possibly cause delays of several hours in delivering messages and presents the possibility that some messages could get misplaced over a period of time. In addition, the potential for misplaced phone messages could result in more problems during an emergency situation. This type of problem has already created a few crisis situations at the BOQ.

Approximately 55 BOQ residents are permanent party for periods up to twenty-seven months while attending NPS. Because there is no internal phone system in the BOQ, many of the residents have telephones installed by the local telephone company and pay all installation costs in addition to their monthly telephone bill.

This type of arrangement is strictly between the BOQ residents and the local telephone company, therefore NPS personnel are not involved. This presents a problem for many of the foreign officers who reside in the BOQ and are not familiar enough with the telephone systems to request service from the local tele-

phone utility company. The final result in this type of a situation, is that the foreign officers have a difficult time contacting their representatives or sponsors.

An internal telecommunication system would allow the residents and BOQ personnel to have immediate feedback on information regarding their telephone bills. However, the most important advantage would be overall improved communications between residents, in addition to front desk personnel.

There are seven rooms in the BOQ which are designated as VIP suites and each room has a private telephone line for dignitaries to place local and long distance telephone calls. In addition, three rooms are designated for flag officers. The problem with this arrangement is that the BOQ Officer receives the telephone bill from the local telephone utility company after the dignitaries have departed. By the time the BOQ Officer receives the monthly telephone bill there could possibly be thirty different occupants for a particular room. As a result, the BOQ Officer must trackdown the occupants in order to pay for the calls, which requires many man hours of labor. In addition, the cost of calls are minimal so it is not cost-effective to track all the persons down for payment. However, the total cost from all the occupants becomes substantial and the balance in payment is paid from BOQ funds. A cost accounting feature included in the new telecommunications system would eliminate this problem in addition to previously mentioned problems.

Another problem encountered because of a nonexistent telecommunication system is the inability of temporary additional duty personnel to contact their parent commands or vice versa. A new system could provide AUTOVON capability to designated rooms in order to meet some of these demands.

The need for an internal telecommunication system in the BOQ could be justified as a result of the problems mentioned above. It is believed that a new system will improve the communications and efficiency for both the residents and the front desk personnel.

## II. ANALYSIS CRITERIA

The cost-effectiveness analysis of this thesis will address some areas which should be considered when analyzing contractors' proposals. The purpose of this chapter is to define cost-effective analysis and then develop the analysis criteria.

The first step of our process begins with a definition of cost-effective analysis which is stated below.

Cost-effective analysis is defined as being that procedure by which costs of alternative means of achieving a stated effectiveness, or, conversely, the effectiveness of alternative means for a given cost are compared in a series of numerical indices [Ref.1: p. 1].

Our analysis will address several areas which can be used in evaluating the submitted bids of contractors. These areas will be explained as to how they relate to telecommunications and how they will be used as cost-effective criteria. The areas are as follows:

- Level of use.
- Inputs.
- Performance.
- Cost categories.
- Minimizing total system cost.

### A. LEVEL OF USE

One of the first things to consider in a new telecommunication system is the level of use. By defining who the system is for, one can determine the number of people using it, in addition to the size of the communication system needed. Table 1 is an example which shows the level of use, or the utility, and the number of the people who will use the system.

**Table 1. LEVEL OF USE**

Level of Use	Number of Users
NPS Staff	10
Front Desk Personnel	5
VIPs	10
TAD Personnel	110
Permanent BOQ Residents	55

## **B. INPUTS**

Measuring the total cost of a system in terms of the identified factors as inputs, is the conventional cost accounting approach based on the market values of those input units. The total cost of a telecommunication system is based on inputs such as material, labor, equipment, maintenance and initial training. Material consists of wire, conduit or any other items needed for installation of the system. Labor costs are related to personnel installing and hooking up the system. The total system cost is also a function of equipment expenses. This equipment includes items such as the main telephone console, CRT terminals and telephones. Attention must be given to the performance of the system and in particular, failure rates of the equipment. Maintenance costs consist of work performed on a routine basis, in addition to the labor cost for performing the maintenance. Finally, the cost of training personnel on the new system is included in the total cost.

## **C. PERFORMANCE**

It is very important for the user to analyze the system performance in order to determine if it meets the specifications. Analysis in this area might include how the system performs during maximum user times. Knowing the failure rate of the equipment is also an important factor which should be considered during the decision process of selecting the communication system. Finally, not only must the elements of hardware and software be considered individually, but their



interrelationships must also be considered in determining their effects on total system performance. [Ref.2: p. 28]

#### **D. COST CATEGORIES**

Cost categories are broken down to particular unit costs of the system. For a new telecommunication system these categories might include equipment, maintenance, installation and training. This procedure can be very effective and provides important data when comparing costs of several vendors.

#### **E. MINIMIZING TOTAL SYSTEM COST**

The minimization of total system cost is important because it allows for further examination of the various alternatives. For a new telecommunication system, alternatives to a copper wire system might include fiber optic cable or a combination of both.

The final result of the analysis criteria leads to the decision-making process. In dealing with a telecommunication system, this process will include a discussion on areas such as equipment technology, equipment availability and psychological stimulus.

Telecommunications is an exploding area where equipment is often outdated after periods as short as three years. Consideration must be given to equipment technology and its compatibility with future models, particularly in relation to expansion capability. Before purchasing a system, further consideration must be given to the status of the equipment such as its availability. A user may not want to wait one or two years for a system to be installed because of delays in equipment availability.

Psychological stimulus could positively effect personnel by increased communications, increased efficiency, and increased productivity of the users. For example, front desk personnel would probably be motivated by a new telecommunication system that was easy to use, in addition to a system which improved their job efficiency. However, a non-userfriendly system could cause frustration among users and defeat the purpose of a new communication system.

### III. STATEMENT OF WORK

A document called the statement of work was developed by personnel from the Public Works Department of the Naval Postgraduate School. It establishes the requirements and defines the responsibilities of the contractor to provide and install a hotel-motel telephone system for the BOQ. This chapter describes the Statement of Work that is intended for the new telecommunication system at the BOQ.

#### A. SCOPE

##### 1. Requirement

The contractor shall provide and install a hotel-motel digital telephone system as defined in this statement of work. The system shall consist of 229 lines and 28 trunks, with expansion capability of 500 lines and 50 trunks. Each station line shall be provided with commercial hotel-motel type service features. One attendant (billeting clerk) console in Building 220 shall be provided. The BOQ telephone system shall provide real time billing data for every local, local toll and long distance toll call made within the system. The billing data shall be available in plain language to the billeting clerk in building 220. The contractor shall provide 10 each 1 way, 2 wire dial pulse/dual tone multi-frequency trunks into the direct distance dialing network; 7 each, 2 way, 2 wire dial pulse/dual tone multi-frequency trunks for Monterey; and toll block.

**Table 2. REQUIREMENT SUMMARY**

	Equipped	Wired	Capacity
Trunks	28	38	50
Lines	229	406	500

## **B. GENERAL REQUIREMENTS**

### **1. Switching System**

The digital switching equipment shall be the standard product of a manufacturer regularly engaged in the production of digital telephone systems and shall be installed in existing space at the Naval Postgraduate School, Building 220.

#### ***a. The Basic PBX***

The basic PBX shall be equipped with dual common control, dual ringing and tone generators with automatic switchover, battery backup, toll restriction, paging adaptor circuit, restricted service capabilities with 6 classes (minimum) of restrictions, vacant number intercept circuit to the attendant and all standard features of the manufacturer's system.

#### ***b. Service Continuity***

Basic facilities provided to accommodate initial requirements shall be such that any growth as reflected in the specification can be implemented without any service interruption or major modification of facilities.

#### ***c. System Compatibility***

The contractor shall insure the compatibility of the system equipment, with all circuits and facilities provided by the local company or other providers of service needed to meet the service requirements of the specification.

#### ***d. Switching Quantities***

The contractor shall be responsible for providing switching equipment quantities identified for the system at cut-over and, as needed, for growth as detailed in the specification.

### **2. Number Plan**

#### ***a. Compatibility***

The contractor shall ensure the compatibility of the proposed system numbering scheme with the numbers for interface with commercial networks.

***b. Future Numbering Plans***

The contractor should consult with the local telephone company regarding any current or future plans to change the listed number and/or the future numbering plan for direct-in-dial from the direct distance dialing networks.

***c. Number Scheme***

The numbering scheme for the proposed system shall include a one digit trunk access code for user access to trunks/services. The following access codes are mandatory:

- (0) Billeting clerk (information and other requests for assistance)
- (7) Local commercial routing (local Monterey area)
- (8) Toll Long distance commercial routing (via Monterey direct distance dialing network)

Access codes to other services shall be coordinated between the contracting officer and the contractor within the limits stated above.

**3. Attendant Console**

The contractor shall provide a minimum of one attendant console for the use with this system. The attendant console shall operate with keys and push-buttons and shall have no cords for call completion or extension. All incoming off-base calls to guest rooms and room to room calls shall occur without the billeting clerk's assistance. Each console shall be equipped with dual operator headset and handset jacks. The attendant console will be located in Building 220, Room 118, in the billeting clerk area.

***a. Full Access***

The console shall have full access to all trunks and stations terminating on the hotel-motel system.

***b. Supervisory Indicators***

The console shall have visual attendant alerting and supervisory indications for each call requiring billeting clerk assistance, accompanied by an audible indication which may be disabled or volume adjustable.

***c. Calling Number Display***

The console shall be provided with a visual numeric display of the calling station number and class-of-service mark on all calls originating from guest rooms to the attendant.

***d. Controlled Restriction***

The billeting clerk shall be able to change class-of-service on lines and trunks from the system access terminal, collocated at the attendant console, and to assign and cancel authorization codes as required.

***e. Split Calling***

The billeting clerk shall be able to converse privately with either the calling or called party on trunk calls through the controls on the console.

***f. Call Completions***

The billeting clerk shall be capable of completing trunk-to-trunk, station-to-trunk, trunk-to-station, and station-to-station calls for all circuits.

***g. Busy Verification***

The billeting clerk shall be able to determine if a busy station line is actually in service. This feature shall place a warning tone on the line being verified before completing the talking path. The billeting clerk shall be able to release a connection after busy verification is completed.

***h. Call Transfer***

The billeting clerk shall be able to transfer trunk calls to and from any station line upon request.

***i. Billeting Clerk Resignaling***

All transferred and waiting calls that have not been completed, shall automatically be returned to the billeting clerk. A visual and audible signal on the console shall be given to the attendant.

***j. Switched Loop Operation***

Each call requiring billeting clerk assistance shall automatically be switched to a loop on the console. The call shall automatically release from the console when answered by the called station. The call may be held at the console if desired by the billeting clerk.

***k. Access to the Console***

Access shall be provided to the console for assistance from any station within the hotel-motel system by dialing an access code. The console shall also be accessible by dialing the separately listed directory number.

***l. Trunk-to-Trunk Connection***

Incoming and outgoing trunk calls shall be able to be extended by the billeting clerk.

***m. Queued Calls***

Incoming calls to the billeting clerk shall automatically be placed on hold when the billeting clerk is busy. The calls shall be distributed on a first-come, first serve basis.

***n. Lamp Verification***

The system shall be provided with a lamp test to verify that all console lamps are serviceable.

***o. Protection and Alarms***

The telephone system shall be completely wired and equipped with trouble signals and fuses. Print-out on the system fault recorder and visual alarms indicating fuse operation and other circuit malfunctions resulting from component failure shall be provided.

**4. Station Equipment**

***a. Telephone Instruments***

Telephone instruments will be single line with dual tone multi-frequency key pads and shall be provided by the contractor. The instruments shall be equal to or better than the quality, design, construction and performance of the telephones used by the local telephone company, and approved for use by the contracting officer. Each telephone will be equipped with a plastic overlay which displays the feature codes available to the user.

***b. Station Wiring***

Station wiring (house cable) shall be provided by the contractor. The following buildings will require station wiring; Buildings 205, 259, 220, and 222 (bachelor quarter spaces only). The total number of rooms is 229.

## **5. Standard Station Features**

### ***a. Room Occupancy***

The contractor shall provide the ability to visually display the occupancy status of rooms. The status of the rooms shall be changeable by the telephone instrument in the room and by a keyboard terminal at the billeting clerk position.

### ***b. Station Restriction***

The billeting clerk shall be able to control the station restrictions placed on any room telephone by using a customer administration panel located at the billeting clerk area. The types of station restrictions required are: outward calls, inward dialed calls, total restriction, and toll call restriction.

### ***c. Automatic Wake-up Service***

The contractor's equipment shall provide an automatic wake-up service. This wake-up service shall permit the billeting clerk to instruct the switch to automatically call a station at a specified time. The billeting clerk shall be able to cancel and activate a wake-up call from the billeting clerk position. The contractor shall provide a printed record of the wake-up request, station (room) number requesting the wake-up, wake-up time, wake-up cancellation, and indication if the wake-up call was answered.

### ***d. Station-to-Station (Room-to-Room) Dialing***

Each station user shall be able to directly dial any other station (unless restricted) within the hotel-motel system without the assistance of the billeting clerk.

### ***e. Station-to-Trunk Dialing***

Stations shall be able to dial and be dialed from any trunk permitted in their class of service treatment without assistance.

### ***f. Station-to-Tieline Dialing***

Stations shall be able to dial and be dialed, from any local tieline permitted in their class of service without assistance.

***g. Dual Tone Multi-Frequency Operation-Touch Tone Pulse***

Stations marked for dual tone multi-frequency operation shall be usable with a touchtone telephone.

***h. Message Waiting***

The contractor shall provide the billeting clerk's position with the ability to activate and deactivate a message waiting lamp at each of the station instruments.

***i. Call Billing***

1. Traffic management data shall be provided on a copy printout for each station and authorization code. Arrangements shall be provided for automatic data printouts on command for variable intervals as required and shall be equipped with automatic start and stop. Measurement equipment shall store data up to 24 hours which shall include all dates and times.

2. The charge for local calls will not be affected by the length of the call. Long distance and mid-distance calls will be charged at a percentage above the telephone company's cost. The printout for each station must have the percentage figured into each call, the percentage will not be listed as a separate cost.

3. Summary report of station must be made available upon request. The summary report must show extension, date, time, duration, location call was placed and cost.

**6. Other Features**

***a. Authorization Code Calling***

Authorization codes shall be provided to allow individual billing when there is more than one occupant assigned to a station. Call completion shall be automatically allowed or denied, based upon the class of service and authorization code dialed for those calls to trunk groups requiring authorization codes.

***b. Uninterruptible Power Supply***

The contractor shall provide an uninterruptible power supply, which shall provide a battery back-up having a 8-hour capacity.



## **7. Cable Distribution System**

### ***a. Telephone Company Provided***

The contractor is responsible for providing complete service to include all necessary house cable, station wire, station connections, and station equipment.

1. The outside cable distribution system where the proposed system is to be installed is the property of the Naval Postgraduate School, Monterey, California. The proposed telephone system is not to be interconnected with the Naval Postgraduate School system.

2. The contractor, in coordination with the local telephone company and government, shall establish the demarcation point or point of connection within the building(s) between the contractor provided equipment and that which is provided by the local telephone company or companies to satisfy system requirements. The point of interconnect for circuits and telephone lines shall be in the existing telephone system equipment room.

3. The switching equipment shall be designed and installed so that the system will be compatible with the commercial network on a direct connection basis.

### ***b. Interconnect Arrangements (Voice-Connecting Arrangements)***

Interconnect arrangements and other local telephone company provided support equipment located on site with the system are required to have continuous power equivalent to that provided for the switching equipment. The contractor shall coordinate these support equipments and power requirements with the local telephone company and be responsible for those facilities necessary to provide continuous power.

### ***c. Contractor-Furnished Cable and Wire***

All cable and wire furnished and installed shall be designed with suitable cross-section to provide safe current-carrying capacity and mechanical strength for the purpose for which it is to be used. Precautionary measures shall be taken by the contractor to prevent cross-talk or other induced interference in the cable. Cables and cable terminals provided and installed shall be equal to the

quality, design, construction, performance of those normally provided by the local telephone company or companies for the particular locations. All cable and wire installed shall be in accordance with all local regulations governing such installations.

## **8. System Orientation and Training**

### ***a. On-Site Orientation***

The contractor shall provide to the government on-site system orientation and training as follows:

(1) *Initial Telecommunications Orientation.* The contractor shall conduct an eight hour (1 day) session covering orientation for government management officials forty-five (45) days prior to cutover.

(2) *General User Training.* The contractor shall conduct system usage training seminars at the Naval Postgraduate School, Monterey prior to cutover at specified intervals, the frequency of which will be negotiated between the contractor and the contracting officer. Approximately eight (8) personnel will attend the scheduled seminars. The program of instruction and a sample seminar shall be provided for the approval of the contracting officer and key management officials twenty (20) working days prior to start of the training.

(3) *Seminar Contract.* As a minimum, the user training program shall provide users, in groups of approximately 25-30 individuals, a one hour orientation on the basic operation of the system. The training will consist of demonstrations and practical exercises in the use of system features.

(4) *Operator Training.* The contractor shall conduct on-site training sessions thirty (30) days prior to cutover date to train personnel in the operation of the billeting clerk position. Instruction shall be on all operational functions and procedures and familiarity with visual and audible signals, and alarms. Instruction shall be conference (25 percent) and demonstration/practical exercise (75 percent). To ensure continuity of operation, all practical exercises will be coordinated with the Contracting Officer or his authorized representative. In the event of conflict between operations and training, operations will have priority. Training hours may be other than normal duty hours in the event that

the operational schedule precludes utilization of equipment for practical exercises. The operator training shall not exceed twenty (20) hours, with each operator receiving training in periods of 1 hour each. Appropriate operation manuals, not less than five (5) each, shall be furnished by the contractor.

(5) *Training Documentation.* Training documentation shall be specified in the applicable Contract Data Requirement List, Form 1423.

## **9. Warranty/Guarantee**

### ***a. Warranty Period and Guarantee***

The contractor shall provide warranty documents indicating that all equipment shall conform to its published specifications and be free from defects in material and workmanship. The contractor shall guarantee all wiring and equipment to be free from inherent defects for a period of (1) year from the date of "in-service" acceptance. Replacement of parts or correction of any such defects, including labor, shall be rendered without additional costs to the government within the guarantee period. Critical repairs shall be responded to within six (6) hours, normal repairs within 24 hours.

### ***b. Spare Parts***

Spare parts list for one year shall be submitted (45) days after award showing part numbers, unit costs and other pertinent information for easy identification, which may be procured at a later date.

### ***c. Maintenance***

A maintenance service contract covering equipment and installation shall be offered to the government. The government retains the right to exercise this option. The contractor must also provide maintenance on an on-call reimbursable basis. The government will authorize all service calls. [Ref.3]

#### **IV. DISCUSSION OF COST-EFFECTIVENESS ANALYSIS**

This chapter will provide an indepth look at cost-effectiveness analysis and how it is used in the selection process. This analysis will include the evaluation of vendor proposals, unpredictables and a discussion of Net Present Value.

In selecting the most desirable system, the user must first determine the total amount that will be allocated for the new system, and the interest rate associated with the loan or allocated funds. An example of cost-effectiveness analysis of a telecommunication system will be discussed, but first some assumptions will be made.

1. Total amount allocated by approval authority: \$100,000.
2. Interest rate for the loan: 5%.
3. Operational life of the system is 10 years; salvage value and disposal costs are zero.
4. Three systems evaluated in the cost-effectiveness analysis process.

In this example, the user has developed system requirements and prepared specifications for the release to all contractors involved in telecommunication systems. Three vendors responded to the request for proposal (RFP), and presented proposals that satisfy the user's requirements.

##### **A. EVALUATION OF VENDOR PROPOSAL**

The total system as proposed by each vendor must be evaluated against the stated user requirements, and the winning vendor selected according to the specified selection criteria. There are two parts to such an evaluation:

1. A system performance evaluation which determines whether all of the systems have the effectiveness required. Here effectiveness is defined as the degree to which the system will meet the future workload and satisfy any constraints.
2. A cost evaluation which determines the total life-cycle cost for each system. This includes the cost of procurement, operation and maintenance of the

system in performing the future workload over the total required operating life of the system.

Implicit in the evaluation is the need to validate the vendor's proposal. It should be stated that this requirement is common to all evaluation procedures and, from a technical point of view, may represent the most time-consuming part of the evaluation. [Ref.2: p. 22]

In order to determine which system is the most cost-effective, an analysis must be performed to integrate the total effectiveness and the total cost. The total effectiveness of each system is determined by listing qualitative figures of merit in the order of highest to lowest priority. Each figure of merit is then assigned a weight with respect to its priority. Some qualitative figures of merit for this example are listed on the following page.

1. Existing Hardware and Software Interface (EHI).
2. Customer Service (CS).
3. Referral Feedback of customer information (RF).
4. Reliability of Vendor (RV).
5. User Friendly System (UFS).
6. Expansion Capability (EC).

Each of the qualitative areas are evaluated against the vendors' proposals, then a value is assigned to each of the figures of merit listed above. The values are from 1 to 5, with 5 being the most favorable and 1 being least favorable. Table 3 describes the utility assignment criteria along with their respective values.

**Table 3. UTILITY ASSIGNMENT CRITERIA**

Utility	Criteria
5	Outstanding
4	Above Average
3	Marginal
2	Below Average
1	Poor

The total effectiveness is represented by  $T_i$ , where  $i$  represents the effectiveness of each vendor. Each of the figures of merit are multiplied by different constants, in order to show that the respective weights vary, from highest to lowest priority. After the figures of merit are calculated, the total value is multiplied by 100 to make the units of the overall cost-effectiveness ratio more manageable. This calculation is shown below in Table 4. The mathematical equation for the total effectiveness is also shown below, along with an example of the weighted values for each system.

$$T_i = 100 [ 10(EHI_i) + 8(CS_i) + 6(RF_i) + 4(VR_i) + 2(UFS_i) + EC_i ]$$

**Table 4. QUALITATIVE FIGURES OF MERIT**

Variable	System #1	System #2	System #3
Existing Hardware Interface (EHI)	10(3)	10(4)	10(5)
Customer Service (CS)	8(3)	8(4)	8(5)
Referral Feedback (RF)	6(3)	6(4)	6(4)
Vendor Reliability (VR)	4(2)	4(3)	4(5)
User Friendly System (UFS)	2(3)	2(4)	2(4)
Expansion Capability (EC)	1(1)	1(1)	1(1)
<b>TOTAL EFFECTIVENESS: <math>T_i =</math></b>	<b>100(87)</b>	<b>100(117)</b>	<b>100(143)</b>

Table 4 shows the levels of effectiveness for each system. In this case, system #3 was determined to have the highest level, and as a result, it is the most effective as compared to the other two.

Each proposal submitted by the vendor must be analyzed in order to determine the total life-cycle cost. This is accomplished by developing a model which includes all of the cost constraints and provides a cost breakdown in each of the relevant areas. The total life-cycle cost is represented by  $P_i$  and the cost constraints to be considered in this example are as follows:

- $f(C)$  equipment cost
- $f(M)$  recurrent maintenance cost
- $f(T)$  training of personnel

- $f(S)$  support cost

The mathematical equation for determining the total life-cycle cost of each system is shown below.

$$P_i = f(C_i) + f(M_i) + f(T_i) + f(S_i)$$

- Where  $f(C) = e + ts(ls)$   
 $e$  = equipment cost  
 $ts$  = equipment setup time, in hours  
 $ls$  = labor cost per hour: (\$40.00)
- Where  $f(M) = \sum_{n=1}^{10} \frac{(t_n \times l_n)}{(1+r)^n}$   
 $t$  = time required for maintenance per year, in hours  
 $l$  = labor cost per hour  
 $r$  = established interest rate: (5%)  
 $n$  = system life: 10 years
- Where  $f(T) = fc + t(ep)$   
 $fc$  = fixed cost of the training  
 $t$  = time required for training in days  
 $ep$  = expense of travel and lodging per day
- Where  $f(S) = m(2,500)$   
 $m$  = support time by the vendor expressed in manmonths; the agreed manmonth cost is \$2,500.

A summary of the proposal costs are shown below in Table 5.

**Table 5. TOTAL PROPOSAL COST**

Variable	System #1	System #2	System #3
e	57,245	74,921	59,339
ts (hours)	50	40	35
ls	20	20	20
t (hours)	25	20	17
l	40	20	20
r	.05	.05	.05
n	10	10	10
fc	50	60	50
t (days)	12	15	10
ep	100	110	95
m (support)	2	2	1
Total Proposal Cost: $P_i =$	68,356.50	85,520.20	66,164.82

[Ref.2: p. 25-26]

After the total effectiveness ( $T_i$ ) and the total life-cycle costs ( $P_i$ ) are determined for each system, a cost-effectiveness ratio ( $C_i$ ) can be obtained to indicate the optimal system. This ratio is determined by dividing the total effectiveness by the proposal cost for each system, respectively. This equation is shown below.

$$\text{Cost - effectiveness Ratio: } C_i = \frac{T_i}{P_i}$$

The most optimal system is determined by the highest ratio of the three systems which, in this example, is system #3 as shown below.

$$C_1 = \frac{8700}{73063.16} = .127$$

$$C_2 = \frac{11700}{85877.80} = .137$$

$$C_3 = \frac{14300}{69054.44} = .216$$



By performing a cost-effectiveness analysis, the user is provided an aid in the selection process. In the previous example, the proposal costs of systems one and three, were very close. Therefore, it is imperative that the user establish a set of criteria, such as qualitative figures of merit, in order to select the optimal system from a well thoughtout, and logical approach. In addition to the vendors' proposals, this process allows the user to evaluate many other areas, such as the equipment, vendor reputation and reliability, maintenance and support. By considering these areas and performing a cost-effectiveness analysis, the user can evaluate the systems more effectively and justify his/her final decision.

## **B. UNPREDICTABLES**

The selection process is complicated by two classes of unpredictables, vendor capabilities and workload uncertainties. Each of these classes will now be discussed in greater detail.

### **1. Vendor Capabilities**

The proposal submitted by the vendor, in addition to cost and contractual-type information, will include the following technical information.

#### ***a. Technical Characteristics***

These are the specifications of the proposed telecommunication configuration together with detailed information about the performance. Assuming that the equipment will perform at the levels claimed.

#### ***b. Software***

In response to the RFP, the vendor will describe those software packages that he will make available with his equipment.

#### ***c. System Performance***

Not only must the elements of hardware and software be considered individually, but their interrelationships must also be considered in determining their effects on total system performance.

#### ***d. Support***

One must be concerned with the ability of the vendor to deliver his equipment and associated software as scheduled. This is just one example of a number of vendor-dependent activities that can be grouped together under the

heading vendor support. For example, the reliability of the vendor supplied equipment and programs can very strongly affect estimates of total system timing. Also, the user's ability to operate the vendor's equipment will depend on the documentation available and on the professional capability of the analysts and support personnel provided by the vendor. Finally, it must be realized that both equipment and software must be maintained. The vendor's ability to do this effectively, efficiently, and timely will influence the user's ability to attain predicted total system performance.

## **2. Coping With Vendor Capabilities**

A number of techniques have been developed for dealing with vendor capabilities. Basically the requirement that the vendor supply off-the-shelf equipment and undergo a live test demonstration removes a large part of the risk associated with making state-of-the-art systems operational.

### ***a. Available Techniques***

The available techniques for coping with the vendor capabilities may be categorized into two major areas.

(1) *Professional Personnel.* The basic ingredient for any evaluation is the availability of competent professional personnel. Such personnel must be carefully trained to stay abreast with the state-of-the-art not just in the equipment alone, but also in the way this equipment may be used. The ability of professional people to interpret and assess vendor claims will be further enhanced through experience. In particular, by working with vendors, a better understanding can be acquired of the features of the vendor's equipment and staff as well as of the marketing strategies employed by the various vendors. In addition, through contact with various other installations, a better understanding can be acquired of the user requirements and problems against which the vendor proposals must be assessed.

### ***b. Systematic Procedures***

Because of the large number of parameters that contribute to the complexity of validating vendor proposals, systematic procedures must be established to provide an orderly context for assessing the vendor's proposal. Given a

competent, professional staff with an appropriate set of tools, it is still necessary to establish an unambiguous set of procedures to assure that the vendor understands the user's requirements, and that the evaluators understand each vendor's proposal. The user's requirements can be formalized into a set of system specifications which can be translated, with the cooperation of the evaluation team, into the Request For Proposal (RFP) that is transmitted to the vendor. By carefully establishing the format and contents of the RFP, the vendor will know what to expect and what to look for in the RFP. By establishing lines of communication between the vendor and the user/evaluation team, the vendor can inform the team of critical areas in his proposal and can receive clarification of any questions on the RFP that may arise. By following systematic procedures, one can assure that all relevant information is equitably disseminated to all competing vendors. Records can be maintained to determine what information was exchanged in case of misunderstandings that may later arise. By applying established validation procedures and evaluation techniques, one can increase the probability that the vendors will accept the results of the validation. In addition, as new techniques or improvements are developed, they can be more readily incorporated into the established procedures. Finally, by having an established chain of approvals for the selection plan and decisions, one has available a set of checks and balances that will assure the vendor of equitable treatment and avoid the aura of mistrust which might otherwise becloud the vendor/evaluator relationship. [Ref.2: p. 27-32]

### **C. NET PRESENT VALUE**

The following paragraphs will provide a discussion of a Net Present Value analysis and the payback period associated with an example. The purpose of performing a NPV analysis is to provide the user with a tool in choosing the most cost-effective system.

The net present value of the proposal is defined as the difference between the total present value of the net cash flows and the cost of the investment. When the net present value is equal to zero, the investment provides a rate of return exactly equal to the rate used in discounting the cash flows. A positive net pres-

ent value means that the investment provides a rate of return greater than the discount rate; a negative net present value means that the investment yields a return of less than the discount rate. Since the discount rate is usually the minimum rate of return required by the investor, proposals with a positive net present value are considered acceptable and those with a negative net present value are viewed as unacceptable. [Ref.4: p. 990]

The payback period is the length of the time necessary to recover the entire cost of an investment from the resulting annual net cash flow. Calculating the payback period can be accomplished in the following manner.

$$\text{Payback Period} = \frac{\text{Amount to be invested}}{\text{Estimated Annual Net Cash Flow}}$$

In selecting among alternative investment opportunities, a short payback period is considered desirable because the sooner the amount of the investment is recovered, the sooner the funds may be put to other use. A short payback period also reduces the risk that changes in economic conditions will prevent full recovery of the investment. Before an investment can be considered profitable, the life of the investment must exceed the payback period. However, the payback period ignores the total life and, therefore, the total profitability of the investment. For this reason, the payback period should never be the only factor considered in a major capital budgeting decision. [Ref.4: p. 986]

Several pay telephones are located throughout the BOQ, where both local and long distance calls are made. Most of the residents are students attending the Naval Postgraduate School from a foreign country or other U.S. military installations. Revenue generated from these telephones, belong to American Telephone and Telegraph (AT&T), who has a contract agreement with the U.S. Navy. This contract allows for the U.S. Navy to receive 20% of the total revenue generated by the pay telephones.

Information concerning the amount of revenue generated by the pay telephones was gathered from the Officer in Charge (OIC) of the Navy Resale Activity, of the Naval Postgraduate School. However, this data is considered to be proprietary information and as a result, it is not included in this thesis. The in-

formation can be reviewed at the OIC's discretion. Listed below are the locations of six telephones, of which, revenues were analyzed from June to November 1989.

- BLDG. 221-Herrmann Hall-East 4th floor.
- BLDG. 222-Herrmann Hall-West 2nd floor.
- BLDG. 221-Herrmann Hall-East 3rd floor.
- BLDG. 220-Herrmann Hall-3rd floor.
- BLDG. 222-Herrmann Hall-West 2nd floor.
- BLDG. 222-Herrmann Hall-West 2nd floor (credit card phone).

During the period of June to November 1989, the above mentioned pay phones generated a total sum of \$22,839.04. The U.S. Navy earned 20% of this amount, which was \$4,567.81. If the BOQ had telephones in each of the residents' rooms, with both local and long distance service available, it can be assumed that the BOQ would obtain a return on its investment of the new phone system. This could be accomplished by charging the residents 20% above the cost for each long distance call and 15 cents for each local call, similar to commercial hotel call accounting systems.

Assuming that a new telecommunication system for the BOQ generated revenues of \$9000.00 per year, a present value analysis can be performed. The present value is defined as: an amount that is expected to be received at a certain time in the future, is the amount which if invested today at a designated rate of return, would cumulate to the specified amount [Ref.5: p. 234]. Using the total proposal costs listed in Table 5, a payback period can be determined by dividing  $P_i$  by \$9000. If the BOQ purchased System # 3 of Table 5, on a no interest loan, the payback period would be 7.4 years. On the other hand, if a loan was agreed upon at a 5% interest rate, the present value of future cash flows would have to be calculated. This can be done by using the following equation.

$$PV(h) = \sum_{i=1}^h \frac{R}{(1+r)^i}$$

Anticipated revenue is represented by (R), the discount rate is (r) and the time period is represented by (h). The present value of future cash inflows PV(h) is determined as the interval goes from one to (h). An example of this concept will follow, using the total proposed cost of System # 3 from Table 5. As shown in the table, the cost for System # 3 is S66,165. As an example, we will assume that this system will produce annual net cash flows of S9000.00 for ten years. The present value of the expected cash flows is determined in the Table 6 below.

**Table 6. NET PRESENT VALUE OF PROPOSED INVESTMENT**

Year	Net Cash Flows	Present Value of \$1 at 5%	Present Value of Net Cash Flows
1	S9,000	.952	S 8,658
2	9,000	.907	8,163
3	9,000	.864	7,776
4	9,000	.823	7,407
5	9,000	.784	7,056
6	9,000	.746	6,714
7	9,000	.711	6,399
8	9,000	.677	6,093
9	9,000	.645	5,805
10	9,000	.614	5,526
Present Value of future cash flows.....			S69,507
Amount to be invested.....			66,165
Net Present Value of proposed investment.....			3,342

This analysis indicates that the present value of the net cash flows from the investment, discounted at an annual rate of five percent, amounts to S3,342 in the time period of ten years. This also means that there is a positive net present value for System #3, and the payback period is nine years as illustrated in Figure 2. It can be shown that System #1 also has a positive NPV, but this value is less than the NPV of System #3, which means that System #3 is more favorable than System #1. In contrast, it can be shown that System #2 has a negative NPV, which means that this system should not be considered over the other two. The NPV of the three systems can be used to get an idea of their respective payback

periods, as shown in Figure 2. This indicates that Systems #1 and #3 have payback periods that are less than the ten year life-cycle of the equipment. In addition, Figure 2, shows that System #2 has a payback period that is over ten years making it less competitive as compared to the other two systems.

It should be noted that depreciation of the equipment was not taken in consideration for this example.

After the user has calculated the NPV of a system, a sensitivity analysis can be performed in order to determine how sensitive the outcome of the NPV is to changes in cash flow. If cash flows increase, then the result is a better investment. However, if cash flows decrease by 10% the NPV becomes negative, which indicates an unfavorable investment. It can be shown, that a decrease in net cash flows of approximately 4.8% is the maximum that can be allowed before the NPV becomes negative.

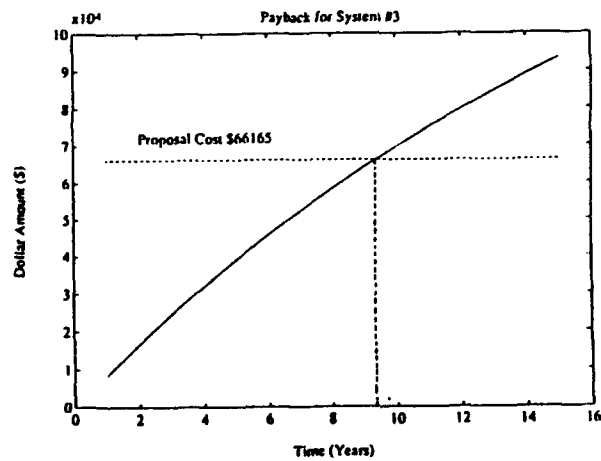
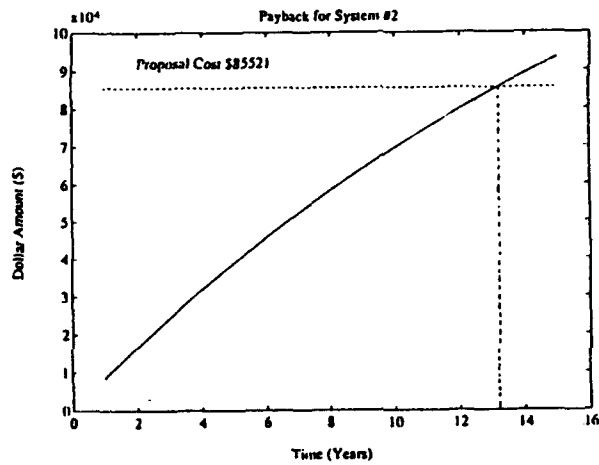
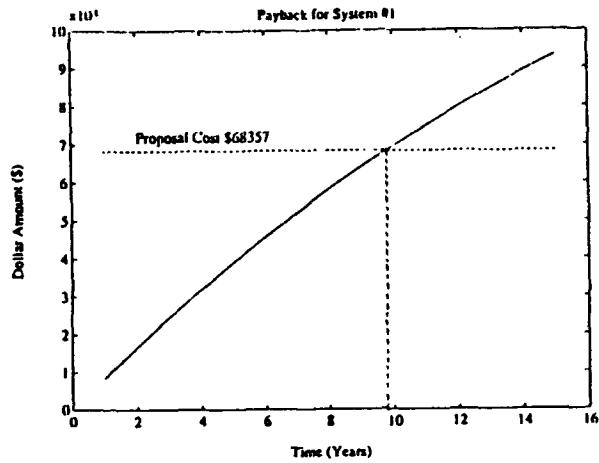


Figure 2. Payback period for Systems #1, #2, #3.



## V. DISCUSSION OF LEASE VS BUY

This chapter is devoted to a discussion of lease versus buy of the telecommunication equipment for the BOQ of the Naval Postgraduate School. Emphasis will be placed on the evaluation of leasing the system as a whole, rather than the evaluation of leasing individual components of the system. In addition, this chapter will provide background on some of the advantages and disadvantages of leasing, which will be followed by a Net Present Value analysis of a vendor's proposal of a lease agreement.

There are many advantages and disadvantages to leasing, and it is the responsibility of the decision maker to evaluate all factors before arriving at a final decision. When a vendor submits a lease proposal, the first step is to have a clear understanding of the lease agreement, which may require the assistance of personnel who have experience in this area. The next step is to list as many advantages and disadvantages as possible, in order to determine if the proposal is affordable and feasible.

In order to determine whether or not the proposal is affordable, the user must know how he plans to finance the cost of the lease and if the present or expected cash inflows are greater than this expense. The user must also analyze the feasibility of the proposal, which can be accomplished by determining whether or not the leased system meets the users requirements and objectives.

In the last fifteen years, capital leasing has become more popular because users have been able to claim some of the lease expenses for tax purposes. Prior to the Internal Revenue Act of 1986, lessors could benefit as a result of investment tax credits along with deductions in the depreciation of the equipment. Those benefits, in turn, helped to reduce lease charges and thus, made it a favorable option as compared to equipment purchases. However, the Internal Revenue Act of 1986 revoked the investment tax credits and removed some of the other benefits as well. It is believed that this Act has made leasing, in some cases, a less popular alternative to purchasing.

A benefit of capital leasing is that it reduces the risk of high overhead costs associated with capital purchases and other expenditures, such as start-up costs. Leasing also reduces the risk of equipment obsolescence, but the lease could constrain the user to an existing system.

A disadvantage of leasing is that the user does not own the equipment and must depend on the lessor for major repairs or equipment modifications. It should be noted, that the lease agreement should include a section concerning the cost of maintenance, and who performs it.

Another disadvantage is that leases can be agreed upon for periods of several years, which can bind the user if financial problems develop and he is not able to make further payments. In situations like this, the lessee can sometimes be released from the contract by paying a penalty fee, depending on how it is worded in the contract. When the user owns the equipment, he has the option to sell the capital during times of financial difficulties.

Listed below are a few advantages and disadvantages of leasing, from the point of view of the lessee. It should be noted that this is a partial list and some may or may not be applicable to a particular user.

#### **A. ADVANTAGES OF LEASING:**

1. Allows for tax advantages (non government organizations).
2. Reduces the risk of high overhead costs.
3. Reduces the risk of equipment obsolescence.
4. May allow for more flexibility in selection and use of equipment.
5. Frees working capital for more productive use.
6. May cost less than other methods of acquiring equipment.
7. May increase the firm's ability to acquire funds.
8. Avoids restrictions frequently found in loan agreements.
9. Assures more adequate servicing.
10. Offers the convenience of making only one periodic lease payment (rather than separate payments for debt service, maintenance costs, insurance, property taxes, ect.)
11. May be tailored to the lessee's needs more easily than ordinary financing.

12. Avoids the necessity of selling equipment no longer wanted.
13. Provides cost-cutting equipment to be installed immediately.

**B. DISADVANTAGES OF LEASING:**

1. Must depend on lessor for major repairs and modifications.
2. Establishes a fixed obligation against the company or organization.
3. Cost for breaking lease agreement.
4. Gives any residual value of the equipment to the lessor.
5. Does not provide the prestige or control that goes with ownership.
6. Raises the fear of dispossession if payments are not made during hard times.

[Ref.6: p. 6-7]

**C. DISCUSSION OF A VENDOR'S PROPOSAL**

In Chapter Three, an analysis was performed on three proposals that were submitted by vendors. In addition to these proposals, vendor #2 also offered a five year lease option at a monthly rate of \$1,834, which will be discussed in the following paragraphs.

From our analysis in Chapter 3, we have concluded that the purchase of System #2 was not affordable because it had a much higher proposal cost as compared to the other two systems. In addition, the NPV of System #2 was negative, which indicates that purchasing this system is not a favorable option. In mentioning affordability, we should keep in mind, that it is a question for both purchase and lease, and the main criterion should be focused on the lowest cost.

If the Naval Postgraduate School leased the system for the BOQ at a cost of \$1,834 per month, the question must be answered as to how to pay for this expense. Would revenue have to be generated in order to pay for this monthly lease cost? One option is to include this expense in the NPS Operations & Maintenance (O&M) budget. However, adding the lease expense to the budget would put it in competition with other expenditures for already scarce dollars. It should be noted, that a further investigation would have to be performed to see if monies used to purchase equipment from a particular budget, could also be used for lease expenses. Some budgets might be used for capital purchases only, and lease ex-

penses might be paid from an entirely different budget, such as O&M. Finally, if money could not be allocated from the O&M budget to cover lease expenses, the user should investigate whether these expenses qualify under any other budgets.

Another option is to allow projected revenue from the new phone system to pay the monthly expense. The problem with this option is that the expected revenue from the new system, mentioned in Chapter Three, amounts to about \$760 per month, which does not cover the monthly lease expense. It should be noted that this revenue was based on a 20% charge above the cost for each long distance call and 15 cents for each local call. In addition, the actual revenue generated by the new system could be less than the expected amount of \$760 if the BOQ occupants chose not to use the system as much as expected.

A third option is possible by combining the first two options. For example, 65% of the lease expense could be paid from the Operations & Maintenance budget and the remaining 35% paid by the revenue generated from the new system. At this point, we might conclude that if money could not be used from the O&M budget, then leasing the system would not be affordable unless the monthly lease expense could be reduced enough to allow for the expected revenue of the new system to cover the cost. It is also possible to increase revenue by increasing the charges for both, long distance and local telephone calls made from the new system. However, this result could have a negative affect, because the occupants might decide to use the new system less, and the pay phones more. In finalizing the three options, a degree of uncertainty exists from an affordability standpoint.

In order to arrive at a final decision between lease versus buy, a NPV analysis should be performed. Using the data submitted by the vendor of System #2, a NPV analysis can be performed and the values of lease costs can be compared against purchase costs.

In performing this analysis, it should be noted that if the user purchased System #2, the life-cycle for the system is ten years, but the lease agreement is five years. For the purchased system, there will be a salvage value at the end of the five year period. In addition, this value must be taken into consideration when

comparing the NPV of the leased system against the NPV of the purchased system.

Before the NPV analysis can be performed, some assumptions will have to be stated. It will be assumed that the salvage value of the purchased system, after five years, is 25% of the purchased cost. In addition, it will be assumed that the five year lease becomes effective in the month of January. A discount rate of 5% will be used as in calculations of the previous chapter.

In calculating the NPV for the lease and purchase options, the cost of the maintenance discounted over the five year period, must also be included. This maintenance cost is represented as  $f(M)$ , which was used in Table 5. The NPV analysis for the purchase option must include the equipment costs  $f(C)$ , support costs  $f(S)$ , training costs  $f(T)$  and maintenance costs  $f(M)$  as mentioned above. The calculations for the NPV of leasing and purchasing System #2 are shown below.

$$NPV_{(Lease)} = \sum_{n=0}^4 \frac{(Mon. \ rate \ x \ 12)}{(1 + r)^n} + \sum_{n=0}^4 \frac{(t_n \ x \ l_n)}{(1 + r)^n}$$

Which leads to:

$$NPV_{(Lease)} = \sum_{n=0}^4 \frac{(1834 \ x \ 12)}{(1 + .05)^n} + \sum_{n=0}^4 \frac{(20 \ x \ 20)}{(1 + .05)^n}$$

$$NPV_{(Lease)} = \$79,458.77$$

The NPV of purchase is:

$$NPV_{(Purchase)} = f(C) + f(T) + f(S) + \sum_{n=0}^4 \frac{(t_n \ x \ l_n)}{(1 + r)^n} - \frac{(.25 \ x \ f(C))}{(1 + r)^5}$$

Which leads to:

$$NPV_{(Purchase)} = 75,721 + 1,710 + 5000 + \sum_{n=0}^4 \frac{(20 \times 20)}{(1 + .05)^n} - \frac{(75,721 \times .25)}{(1 + .05)^5}$$
$$NPV_{(Purchase)} = \$69,017.05$$

As shown above, the NPV analysis of the purchase option has a lower value as compared to the lease option. As a result, it appears that purchasing the system would be more favorable than leasing. It should be pointed out that a similar NPV analysis should be performed for the other two systems if data were available. The results should be similar because the same procedure for calculating the NPV would be used. Furthermore, the same financing and tax shifting conditions, would exist for all three systems.

In summary, the decision to lease or buy involves both a qualitative and quantitative analysis. In making this decision, the user should list all of the advantages and disadvantages of leasing a system and perform a quantitative analysis, such as the NPV, in order to determine if the lease or purchase options are both, affordable and feasible. In addition, it is also important for the user to thoroughly understand all parts of the lease agreement to avoid any hidden costs or misunderstood terms.

## VI. CONCLUSIONS

This chapter will discuss some considerations that can enhance or complicate a cost-effectiveness analysis. Particular areas of concern are related to: time constraints, availability of data, assignment of weights and environmental effects. Following these concerns, will be a summary of steps to serve as a guideline to the successful implementation of a telecommunication system.

As mentioned in an earlier chapter, a cost-effectiveness analysis can be very beneficial in selecting the most efficient and cost-effective system. However, it should be mentioned that this analysis can be a very time consuming affair, and as a result, the user should budget time for designing the analysis, in addition to collecting and analyzing the data. The time allowed for each of these areas depends on: the complexity of the equipment or system, the number of variables and external factors and the availability of the data.

A more in-depth analysis could have been performed in this thesis if additional time and the appropriate data were available. In particular, it would have been beneficial to evaluate further, a history of the number of callers who called the BOQ front desk in order to have a message delivered to an occupant. This information might further help in the justification of a new or more efficient telecommunication system. Data would also have been helpful from other Navy BOQs, concerning the increase or decrease in the number of calls after the installation of a new telephone system, and at similar rates used in this thesis. This information could be used for demand forecasting purposes, and provide the user with relevant information as to the expected use and opportunity cost of a new system. In addition, this data would also help to reduce some of the risk to the user.

The weights assigned in the cost-effectiveness analysis are subjective and may vary to some extent, as compared to an analysis performed by others. In order to perform a thorough analysis, the user should have a clear understanding of

each figure of merit, and follow a set criteria in assigning weighted values. It is very important for the evaluator to be consistent throughout this process.

In performing a cost-effectiveness analysis, certain environmental conditions can exist which could possibly cause the analysis to become obsolete or not relative to current market conditions. For example, the discount rate used in the net present value calculations of this thesis, could vary in accordance with the present market discount rate. However, the procedure in calculating the NPV is the same, and can be applied to each respective system, regardless of the value of the discount rate.

Environmental conditions relating to commercial and industrial markets, can also have an effect on the life-cycle of equipment and systems. For example, some computer and communication systems today have shorter life-cycles because of the rapid change and advancement of high technology. In addition, changes in federal policies or tax legislation dealing with communication systems can also have an effect on the value of a system. An example of this might be the federal government providing industry with tax incentives for purchasing fiber optic systems because of their high efficiency rating. This in turn, might cause a decrease in value of copper wire systems owned by some companies.

Summarized below are a set of general guidelines for the user to follow or consider, for the successful implementation of a telecommunication system.

1. Define the user requirements. Interview system users and operators to learn what they expect the system to do. Consolidate these requirements into a statement of work or request for proposal.
2. Justify the expenditure. Concentrate on identifying tangible benefits and how the system will help achieve better efficiency and accomplish goals. Determine the total installation and operating costs.
3. Analyze the impact on the organization. Determine if more or less personnel will be required for the new system. Determine if the personnel are capable of operating the system.
4. Select the equipment.
  - Identify several qualified vendors.
  - Submit bid invitations.
  - Evaluate vendors' proposals.
  - Make a final decision.



5. Help users to accept the change. Attempt to eliminate insecurities that personnel might have about the new system.
6. Prepare the site. Re-arrange office space or facilities to accommodate the new system.
7. Prepare operating procedures. Ensure that operating procedures are clearly defined and that personnel understand them.
8. Establish training program for personnel. Time required for training will depend on the: knowledge of the personnel, user-friendliness of the system, availability of good vendor training material, and clarity of operating procedures.
9. Evaluate system, procedures and personnel. Post-installation evaluation is needed to fine tune the system and provide valuable feedback to the vendor. Establish a file for maintenance records and any other appropriate correspondence.

[Ref.7: p. 231]

The guidelines stated above are applicable to the user whether the system was purchased or leased. However, some of the guidelines may be more applicable than others, depending on the priorities of the user.

In closing, there is usually a certain amount of risk associated when purchasing an expensive and sophisticated telecommunication system. By performing a cost-effectiveness analysis, this risk can be reduced to a certain degree. Performing a net present value analysis can also provide the user with a tool to help in choosing the most efficient and cost-effective system. Finally, it can also be used as an effective tool in the decision process of lease versus buy.

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