CHAPTER I: AN APPROACH TO THE STUDY OF RETRIEVAL SYSTEM OPERATING EFFICIENCY

A. Statement of the Problem

The National Criminal Justice Reference Service (NCJRS) is "an agent of the Law Enforcement Assistance Administration (LEAA) for the collection, management and dissemination of information to support the national effort to deter and prevent crime."* NCJRS is a non-profit organization which is being monitored and controlled by LEAA, but operated by General Electric for a specified contract fee. The Service was established on August 10, 1971. Since then, the operating system has undergone many changes; in fact, it is continuously changing.

The Program of Policy Studies in Science and Technology (The George Washington University) undertook a critical review of the operating efficiency/effectiveness of NCJRS in fulfilling the purpose which it is designed to serve. The study is an interim evaluation of the NCJRS and establishes evaluation measures that can be employed periodically in the future.

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*From the NCJRS System Manual.

B. Estimated Study Boundaries and Constraints

The study evaluates the internal operations of NCJRS as they relate
to its goals and the definition of an information retrieval system. Since a statis-
tical study derives much of its validity from data that covers historical
as well as current levels of activity (such data makes it possible to
establish trends and evidence of changes over time), the study was based
primarily on data available from the ongoing reporting procedures of the
system.

Not all aspects of NCJRS operations could be traced from these records.
Some were partially reconstructed; others were found to have only a few
data points; others were reasonably complete. It is well known that the
cost of creating time and cost records for the many transactions of an
information center often exceed the perceived benefits, so the absence
of such data is not unexpected. Accordingly, this report is based on the
data available plus current data generated in the course of the study.

The study critically analyzes the relationship between operating
efficiency and effectiveness. However, the study methodology is geared
to analyze the operating efficiencies rather than to quantitatively
measure the level of effectiveness of the system among its user population.
The study was conducted over a four-month period (December 1974
through March 1975) during which NCJRS moved to a new location. This cre-
ated some timing problems for this study in terms of the sequential
analysis of stages of operation within NCJRS.

NCJRS consists of three subsystems characterized by considerable
independence:

    0   The document storage and retrieval system

● The LEAA document distribution system

● The writing/publishing system in support of the National Institute of Law Enforcement and Criminal Justice (NILECJ).

These three subsystems are interrelated through a single management and common manpower pool which form a highly complex mosaic.

The NCJRS system is characterized by shifting emphases and priorities and occasionally by conflicting claims for staff time and attention. To maintain a constant balance, there is a great need for upward flow of information.

The study analyzes the first two subsystems which relate directly to the NCJRS goal/definition of being an information retrieval system. The system's multiple objectives and the tasks of the different subsystems are being accomplished through the use of the limited capacities (costs, manpower, management), which reduces the actual and potential effectiveness of NCJRS as an information retrieval system.

The NCJRS document storage and retrieval system is complex in terms of its information flow. Many of the system's well-defined operational stages may occasionally perform tasks from other stages, i.e., the document processing department may be directly connected to publishers and other data sources which is a part of the acquisition department's task.

As a complex system* NCJRS may be assumed to have the following behavior/characteristics; it is:

● Counter-intuitive

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*The characteristics listed are typical of complex systems as perceived in general systems theory.

●　Insensitive to changes in many system parameters

●　Resistant to policy changes

●　Influenced by pressure points from which forces radiate to
alter system balance

●　Counteracting and compensating for externally applied corre-
ctive efforts

●　Reactive to long-run policy changes opposite to short-run
changes

●　Tending toward low performance

(handwritten: ? o vary / definition of)

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C. Goals and Objectives

The study has four major goals:

● To conduct an in-depth literature search, and to develop measures of working efficiencies for a non-profit information retrieval system;

● To develop and apply an efficiency model to historical and current levels of operation of NCJRS in order to draw certain conclusions about the conduct of the organization;

● To provide a desirable set of measures for future use in order to direct the system to higher levels of effectiveness; and

● To create relationships between internal efficiency and total system effectiveness to direct future changes in the system's operational goals.

To accomplish these goals the following intercorrelated and integrated tasks were defined:

● Evaluate present and historical trends of NCJRS activities and services;

● Evaluate user class frequencies and preference trends;

● Analyze NCJRS document flow;

● Perform cost analysis;

● Analyze NCJRS capacities; and

● Relate growth to efficiency and effectiveness.

D.   Literature Search*

A literature search was performed in conjunction with this study to determine the nature of existing methodologies for the evaluation of information systems and to determine whether such methodologies would be directly applicable to an evaluation of the National Criminal Justice Referral System (NCJRS). In addition, the literature search was intended to determine whether data existed which could be used to compare the operating costs and efficiency of the NCJRS with that of other systems. A bibliography of the publications selected for these purposes is included in Appendix A, along with available author abstracts. This survey is not intended to be exhaustive, but rather to provide the reader with an overview of the literature which represents the range of viewpoints and methodologies currently accepted.

The literature surveyed can be summarized by the following general statements which will be elaborated in the remainder of this section:

1.   It is necessary and possible to calculate the costs of the operation of information systems and to measure the efficiency of these operations (cost-effectiveness); no single methodology is in general use.

2.   Once operational costs are determined, the effectiveness of the system remains to be determined and this qualitative measurement is dependent upon (a) clear definition of goals, (b) analysis of user motivation and satisfaction, and (c) some correlation of the two with quantitative measures, such as volume of input and output and costs (cost-benefit); again no single methodology is in general use.

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*The complete bibliography for the literature search appears in Appendix A, pages 86 to 99.

3. Comparison of results of cost-effectiveness and cost-benefit analyses is difficult, if not impossible, because of differences in (a) the systems surveyed, (b) parameters measured, and (c) the definition of these paremeters.

1. Cost-effectiveness. Cost effectiveness analysis has been defined by F. W. Lancaster as "the relationship between level of performance (effectiveness) and the costs involved in achieving this level."[1] A "less romantic and more down-to-earth" explanation is given by Alan Gilchrist as "a method of finding either (a) the cheapest means of accomplishing a defined objective, or (b) the maximum value from a given expenditure."[2]

Acknowledging the difference between information systems and other production-oriented functions is recognized as a basic concept that must precede any attempt to measure cost-effectiveness; Janice Ladendorf summarizes this difference in the following manner:

> The basic problem is that libraries are both like and unlike normal profit-making businesses. They resemble a normal business in that managerial techniques do exist which can be used to promote efficiency in their routine operations. However, libraries are unlike profit-making business in one very important and fundamental way. They produce services for users, not products whose sales can be measured in dollars and cents.[3]

Accepting this basic difference, many of the authors whose work was reviewed establish a premise that "the actual value of the information provided to or acquired by a research scientist to support his research cannot be determined... [but] the cost of the information can and should be."[4] In this manner they reduce the problem to a cost-effectiveness

analysis and avoid the problem of determining the cost-benefit of the system.

Monroe Freeman gives two reasons for measuring the costs of information systems: (a) "good cost and production data will do as much as anything else to inspire the confidence of the prospective donor of funds or support," and (b) "good cost and production data for each unit process of the system and for each unit product and service are essential for positive control of the work flow, and for the economy of the total system."[5] Many of the authors surveyed acknowledge the practical necessity for cost-effectiveness measures in order to justify their budgetary requirements. Douglas Price presents the same point of view in the following statement:

> In these days of tightened budgets and almost universal application of planning, programming, budgeting (PPB) systems ... librarians and information scientists must have rational, usable cost information and real control of costs if they are to survive.[6]

General agreement also exists on the need to separate the various functions of an information system into units that can be measured individually and in conjuntion with other elements of the system. These are usually divided into two categories, input and output, and then further subdivided into the processes for acquiring, manipulating (cataloging, abstracting, indexing, etc.) adn storing the information and into retrieval through products and services (loans of material, preparation of bibliographies, selective dissemination of information (SDI) services, etc.).

Obviously the input costs can be summarized by a statement of the overall budget of the information system, including appropriate overhead

costs. Detailed review is then needed to separate out the logical units for specific measurement and analysis. Lancaster points out that:

> The cost of an information service can be measured in terms of input of resources (funds). Under costs we need to consider both the costs that are relatively fixed (e.g., equipment purchase or rental, development costs, costs involved in acquisition and indexing of the present data base) and the costs that are relatively variable. Variable costs are two kinds: 1. The variable cost that is a function of the number of transactions.... 2. The variable cost that is a function of alternate modes of operating the system.[7]

Once processing untis or cost elements have been selected and defined, the methods of measurement generally described are standard accounting practices, collecting data on actual expenditures (as for acquisitions, supplies, etc.), on manpower allocated for specific functions, and overhead costs applicable to the unit, and then determining the total costs and dividing them by the total output (number of items acquired, processed, indexed, etc., or number of requests for service filled) to determine the unit costs.

> These [cost] elements could be summed for evaluation and management control of each operating unit itself. They could also be sorted in another way so that the cost elements in each operating unit were identified with each input or inventory item and with each of the output products or services.[8]

This in turn can allow the management of the information system to determine the upward parameters that they are willing to tolerate or support. If the funds are fixed at a given level, then the variables must be manipulated to maximize the number of transactions that the system can support. The more efficient the methods of operation (cost-effectiveness), the more transactions (services) can be provided within the fixed costs. Obviously this manipulation in itself has limitations since the fixed costs will usually comprise the bulk of the budget and thereby limit the

degree of savings possible through greater efficiency.

> A cost effectiveness analysis seeks to increase the value
> received (effectiveness) for the resources expended (cost).
> We can improve the cost-effectiveness of an information system
> in two ways:
> 1. Maintain the present performance level ... while reducing
>   the costs of operating the system.
> 2. Holding operating costs constant while raising the average
>   performance level.[9]

Some of the pitfalls in cost-effectiveness analysis are based on

the methodologies used for collection of data. Price indicates that

the three basic methods of data collection are through interviews,

sampling, and time studies, and he points out that each of these has

its own inherent weaknesses. To overcome these problems he suggests

that:

> Valid unit cost must be derived from data which are
> collected: in normal operations; in sufficient detail and
> over a sufficient period of time to permit statistical analysis;
> and, most important, in a manner which permits the costs to be
> related to the actual production resulting from the expenditure.[10]

Another problem that must not be overlooked is the "unpredictable

and widely fluctuating workloads of both input and output (that) cannot

be controlled."[11] (This is true of most information systems, and is

particularly true of NCJRS as will be discussed in the sections of this

report which analyze the acquisition and user service functions.) The

best a cost-effectiveness analysis can do is to identify these areas of

fluctuation and attempt to call management attention to the need for

either stabilization (if possible) or adaptation to these problems.

The type of data collection and analysis presented above can be of

considerable use to information systems managers, but: