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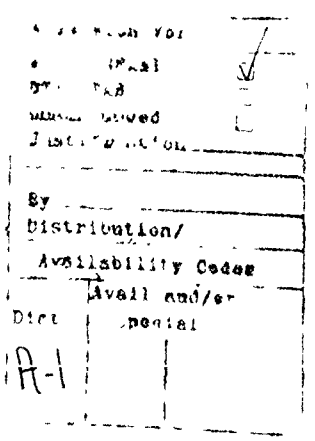
A Manual on the Evaluation of Information Centers and Services

(Manuel pour l'Evaluation des Centres et Services d'Information)

NORTH ATLANTIC TREATY ORGANIZATION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(ORGANISATION DU TRAITE DE L'ATLANTIQUE NORD)

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A Manual on the Evaluation of Information Centers and Services

(Manuel pour l'Evaluation des
Centres et Services d'Information)

by

José-Marie Griffiths
University of Tennessee

and

Donald W.King
King Research, Inc.

This publication was sponsored by the Technical Information Panel of AGARD.

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Avant-Propos

L'OTAN avait organisé dès 1965 un Cours Avancé d'une qualite exemplaire sur l'Evaluation des Sytèmes d'Information, cours qui réunissait à la Haye les meilleurs spécialistes en service de l'information.

La notion de système est importante parce qu'elle permet toutes les évolutions souhaitables pour une meilleure satisfaction des besoins de l'utilisateur. Elle permet à la cybernétique de laisser sa place à l'humain. Elle montre que l'efficacité est liée à la mesure d'un certain nombre de paramètres qu'il faut savoir identifier et maitriser.

Au sein des pays de l'OTAN les grands centres ou services d'information ont une part importante de responsabilité dans la construction et l'évolution des systèmes nationaux. C'est pourquoi la Commission de l'Information Technique de l'AGARD a organisé en septembre 1988 une Série de Conférences sur le thème de "l'évaluation des Centres et Services d'Information" au Luxembourg, en Grèce et au Portugal. Les textes de ces conférences ont été rassemblés dans la série de conférences no.160.

La Commission a alors demandé au directeur de la série de conférences de combiner le contenu de ces présentations et l'expérience qu'il a lui même acquise à l'occasion de sa participation à des actions d'évaluation de centres et services d'information, de façon à préparer un manuel tenant lieu de synthèse: c'est le volume présenté ici.

A l'heure où il apparait clairement que "l'investissement immatériel" dans l'information est essentiel si l'on veut rester compétitif, le manuel permettra à tous ceux qui ont une responsabilité dans la gestion et le transfert de l'information de tirer le meilleur parti des ressources et moyens à leur disposition, d'être "proactifs" plutôt que "réactifs" en mettant en place les systèmes de mesure, les tableaux de bords, qui faciliteront les prises de décision.

Je remercie les auteurs de ce manuel, José-Marie Griffiths et Donald W.King, qui ont me semble-t-il parfaitement réussi à regrouper et à organiser dans cet ouvrage les connaissances des meilleurs experts du domaine et donc à faciliter la mise en place de ces systèmes de mesure et d'évaluation.

Ce manuel devrait faire l'objet d'une large diffusion auprès des personnels techniques et administratifs qui ont ou sont appelés à avoir un rôle important dans la gestion et le transfert de l'information.

ALBERT YANEZ
Président de la Commission de
l'Information Technique de l'AGARD

Foreword

In 1965, NATO organised an advanced course on the evaluation of information systems. The course was of an exemplary standard and brought together at the Hague the leading specialists in the field of information services.

The concept of system is important, as it provides the necessary flexibility for a type of development more in line with user requirements. It enables cybernetics to give way to the human being. It demonstrates that efficiency is linked to the ability to measure a number of parameters which the user must know how to identify and master.

In the NATO nations the major information centres or services have a large share of responsibility for the design and development of national systems For these reasons, the Technical Information Panel of AGARD held a Lecture Series on "The evaluation of information centres and services" in Luxembourg, Greece and Portugal. The texts of the lectures are contained in Lecture Series No.160.

The Panel then commissioned the Director of the Lecture Series to combine the material presented there with the experience he had gained in many projects involving the evaluation of information centres and services, and prepare a unified manual (this AGARDograph).

At a time when it seems clear that "grey matter investment" in information is vital if we are to remain competitive, this manual will enable all those responsible for the management and transfer of information to get the best out of the resources and facilities at their disposal, and to be "proactive" rather than "reactive", by setting up measurement systems which act as instrument panels for those responsible for making the decisions.

I would like to thank the authors of this manual, José-Marie Griffiths and Donald W King, who, in my opinion, have successfully brought together and structured in one volume the knowledge held by the leading experts in the field, and by so doing have facilitated the implementation of these measurement and evaluation systems.

This manual should be widely disseminated among the administrative and technical personnel who have or will have an important role to play in the management and transfer of information

ALBERT YANEZ
Chairman
Technical Information Panel of AGARD

Preface

This manual on "The Evaluation of Information Centers and Services" grew out of AGARD Lecture Series No 160 entitled "Evaluating the Effectiveness of Information Centres and Services" The Lecture Series was given by.

Dr. José-Marie Griffiths, King Research, Inc.
Donald W. King, King Research, Inc.
John Martyn, Polytechnic of Central London
Professor Jack Meadows, Dean, Dept. of Library Information Studies
Dr. David Penniman, AT&T Bell Laboratories

in September 1988 in the host countries of Luxembourg, Greece, and Portugal

Readers of this manual are particularly recommended to read the papers[1]

Measures, Methods and Models Employed in Evaluating the Effectiveness of Information Centres and Services, by A J Meadows

European Examples of Evaluating the Effectiveness of Information Centres and Services, by J. Martyn

Evaluating for Information Centre Planning, by W. E. Penniman.

This manual deals largely with extensive evaluations done by King Research over the past fifteen years. The genesis of the approach to evaluation of information centers and services discussed here began with a National Science Foundation study published as a book[2] in 1971. Since that time the approach has been modified somewhat and extended considerably as a result of nearly 300 projects involving planning, evaluation and design of information centers and services. We emphasize that the general approach presented here (including suggested measures, models and methods) are not the only ones that one might use Rather, the approach in this manual is a result of the particular knowledge we have gained and it reflects what we have found to be applicable and useful to funders, managers, information center staff and information service users. For other approaches to evaluation, we refer the reader to the bibliography at the end of the manual and, in particular, the works of Buckland, Hayes, Kantor, Martyn, Meadows, and Penniman.

In this manual we emphasize evaluation measures, models, and methods and we usually present actual data and results from studies performed by King Research A companion book, "Special Libraries and Information Services — Increasing the Information Edge"[3] represents an overview of the results of these studies. Also, we prepared "Keys to Success Performance Indicators for Public Libraries"[4] that provides an additional perspective for using evaluation measures and indicators

José-Marie Griffiths, Ph D.
Donald W. King

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Chapter 1

The Role of Evaluation

1.1 Background

Information systems evaluation has been extensively discussed in the literature over the past thirty years and there have been many exemplary evaluations performed over the years. However, we believe that evaluation of information centers and services is likely to take on new significance in the 1990's. Institutions of all kinds worldwide are undergoing intensive scrutiny in terms of their performance and effectiveness, we believe properly so. It is no longer accepted as matter of fact that information centers are necessary or that all services are needed. Information centers are undergoing increasingly strong competition for funds within their companies, educational institutions, government agencies or other organizations. We believe that such competition will become even more intense during the 1990's. Unfortunately, many information centers are not well prepared to meet this competition. They typically do not measure or keep data that are useful for making a compelling case for themselves in a highly competitive environment.

Most information centers that we have dealt with maintain their management information or data in terms of budgeted items that reflect resources such as staff, collections (stock), equipment and systems, and facilities. Sometimes information center managers allocate budgets to specific services, but rarely do they measure the performance of those services in terms of productivity or output quality, timeliness, etc. It is even rarer for information center managers to establish the effectiveness of their services in terms of user satisfaction, the extent to which services are used and the consequences of use of the services in terms of the purposes for which services are used and how services affect users' work. We believe that in the future, budgets for information centers and services will be considered an investment and return on that investment must be considered in terms of how effective services are for meeting the organizations' mission, goals and objectives.

Throughout the Manual are several recurring evaluation themes:

- *Evaluation must have a purpose it must not be an end in itself.* The purpose of evaluation arises out of a need to "set a value on" an information center and services. Lord Kelvin has said that "..when you can measure what you are speaking about, and express it in numbers, you know something about it; but when you cannot measure it, when you cannot express it in numbers, your knowledge is of a meager and unsatisfactory kind..."[5].
- *Without the potential for some action, there is no need to evaluate.* Whether evaluation is used for budgeting, planning, administration, design or other functions, it should lead to decision-making, which is a prelude to action.
- *Evaluation must be more than merely descriptive;* rather, evaluation must take into account relationships between operational performance and effects on the users and organizations being served. In addition to merely measuring costs and amounts of services provided, it is important to be able to relate costs to a combination of service quantities, quality, timeliness, etc. and, in turn, to relate quality and timeliness to user satisfaction, extent of use and consequences of use.
- *Evaluation should be a communication tool where feedback to and from staff and users is unimpeded.* All evaluation should be addressed to, made known by and used by information center funders, managers, staff and users. We strongly advocate a participatory approach to evaluation. Information center staff must know the objectives and possible outcomes of evaluation. They can contribute substantially to evaluation through their intimate knowledge of operations and users. They can also perform their work better as a result of knowledge gained through evaluation, whether it be operational or user-related knowledge. We have found that users also can benefit from the knowledge gained through evaluation — sometimes regarding their interface with service staff, use of services or how information affects their work.
- *Evaluation should not be sporadic in nature, but rather should be considered as an ongoing management tool supported by an ongoing system of measures or management information system.* Nearly all evaluation reported in the literature involve one-time studies. However, ongoing evaluation can be relatively inexpensive, because observation and analysis costs are spread over time. Furthermore, a one-time evaluation provides a baseline measurement only. It is the ongoing evaluation subsequent to action that provides important information on the effects of action.
- *Ongoing evaluation should provide a means for continual monitoring, diagnosis and change.* Such ongoing evaluation makes managers proactive rather than reactive. By observing trends in critical measures and indicators, managers can set measurable objectives which help fulfill meaningful goals and missions of the center and services. A system of measures will provide diagnostic tools for determining why objectives are not achieved and what the consequences of not meeting the objectives are to the parent organization.
- *Ongoing evaluation should be dynamic in nature, in that evaluation measures, models and methods must reflect new knowledge and changes in the operational, user and organizational environment.* Changes in information center operations and services will of necessity require different evaluation measures, models and methods. Furthermore, knowledge gained through continued observation and analysis will dictate modification to evaluation procedures, measures, models and methods.

Evaluation costs money and uses resources that might be applied for competing functions in the center. The investment is in information that should lead to better decision-making and ultimate savings to the information center. The favorable consequences of evaluation and ongoing system of measures must exceed the costs. Unfortunately there is little documentation, except through anecdotes to demonstrate this. On the other hand, circumstances in the future may impose the need for continued evaluation and it behooves information center management to be prepared for this. We are aware of no guidelines regarding how much evaluation should cost. However, we believe that ongoing evaluation and systems of measures should cost in the neighborhood of two to five percent of budget. When a large-scale change is anticipated such as purchase or development of a major automated system or a move to new facilities, approximately five percent of that budget should be set aside for special-purpose evaluation tied to the ongoing evaluation. One can cite hundreds of examples where, without proper evaluation, the cost of mistakes made in purchase of new systems cost the information center literally ten to 20 times the recommended amount of five percent investment in evaluation.

1.2. The Role of Evaluation

We emphasize throughout the Manual the many roles that evaluation plays in information centers. We also stress that evaluation should not be a one-time process but rather should provide a continual system of measures and management information. In particular, evaluation and a system of measures should assist in the following functions.

- Planning
- Resource management
- Operational function and service management
- Promotion, marketing and public relations

The role of each of these functions is discussed below.

Evaluation During Planning

Basically, the planning process is a structured framework for continuous problem solving based on a combination of objective and subjective information. The role of evaluation in this process is to provide the basic information for designing and redesigning information center operational functions, services, or systems. A planning manual was developed by Palmour and colleagues at King Research [6] and evaluation aspects from that manual are described below.

Planning entails making decisions based on predicted effects of alternative actions. Decisions are also made on the basis of results of past decisions. This is the control function of both planning and evaluation. Techniques most often used in evaluation during the planning process include observational studies, surveys, and descriptive models of the system. For example, once a planning group or committee has developed several strategies for possible implementation, it is necessary to evaluate the strategies to determine the best methods of reaching the desired ends. Techniques used for evaluating proposed strategies (i.e., for evaluating alternative actions for accomplishing the previously determined objectives) include cost finding, assessment of center records, surveys and experimentation. Evaluation provides a guide for considering the probable impact of a strategy upon each objective. The question is essentially "How much better can the center, system or new technology accomplish each of its objectives if the strategy is adopted and implemented?" Because a strategy designed to further one objective may affect another, for better or worse, each strategy has to be evaluated against each objective. This requires some means of anticipating or forecasting the incremental gain or loss from what is currently being accomplished. This may be a subjective exercise, because it relies on the expectations of the effects of strategies on objectives; but it is absolutely necessary to evaluate strategies for possible implementation. There is also the experimental approach, whereby strategies are tested by limited application in only one part of the system.

Planning, like the evaluation process it includes, is ongoing. A long-range plan is developed as part of the initial cycle of the planning process. It includes the monitoring and evaluation of the center's plan itself and evaluation of the continued relevance of current center operations, services, and products to the needs of the users to be served.

Planning involves setting an information center's mission, goals, measurable objectives, priorities and strategies for achieving change. These aspects of planning and management are defined as follows:

- *Mission* should be an overall statement of the information center's role in meeting its parent organization's mission, goals and objectives. It should reflect the center's philosophy in providing service.
- *Goals* are broad statements of desired ends such as an increase in the number of users, an increase in the use of services, automation of certain functions, development of new services, etc.
- *Objectives* are specific targets within the goals, and there may be several objectives for each goal. The objectives should be measurable, if possible
- *Priorities* should be set among objectives to help make decisions on actions under various funding and other resource limitation/contingencies.
- *Strategies* for change are the actions which can be taken to achieve the goals and objectives

In our framework for evaluation we stress several perspectives for evaluation including the information center (management and staff), users and the user's organizations (often the funder of the center) The mission statement should include some language from the organization's perspective, some goals must include meeting users' information needs and requirements, and some objectives can include performance and effectiveness measures. We show that we can link information service performance to users' performance. Thus, one can conceptually also link the information center's performance to the objectives, goals and mission of the parent organization.

Evaluation and information requirements for the planning process (for public libraries) were developed as shown in Figure 1 The structure holds for information centers as well.

A useful application of evaluation is in planning and designing systems and automation in information centers. It is essential in planning, feasibility analysis, design, development and operations. Evaluation involving new

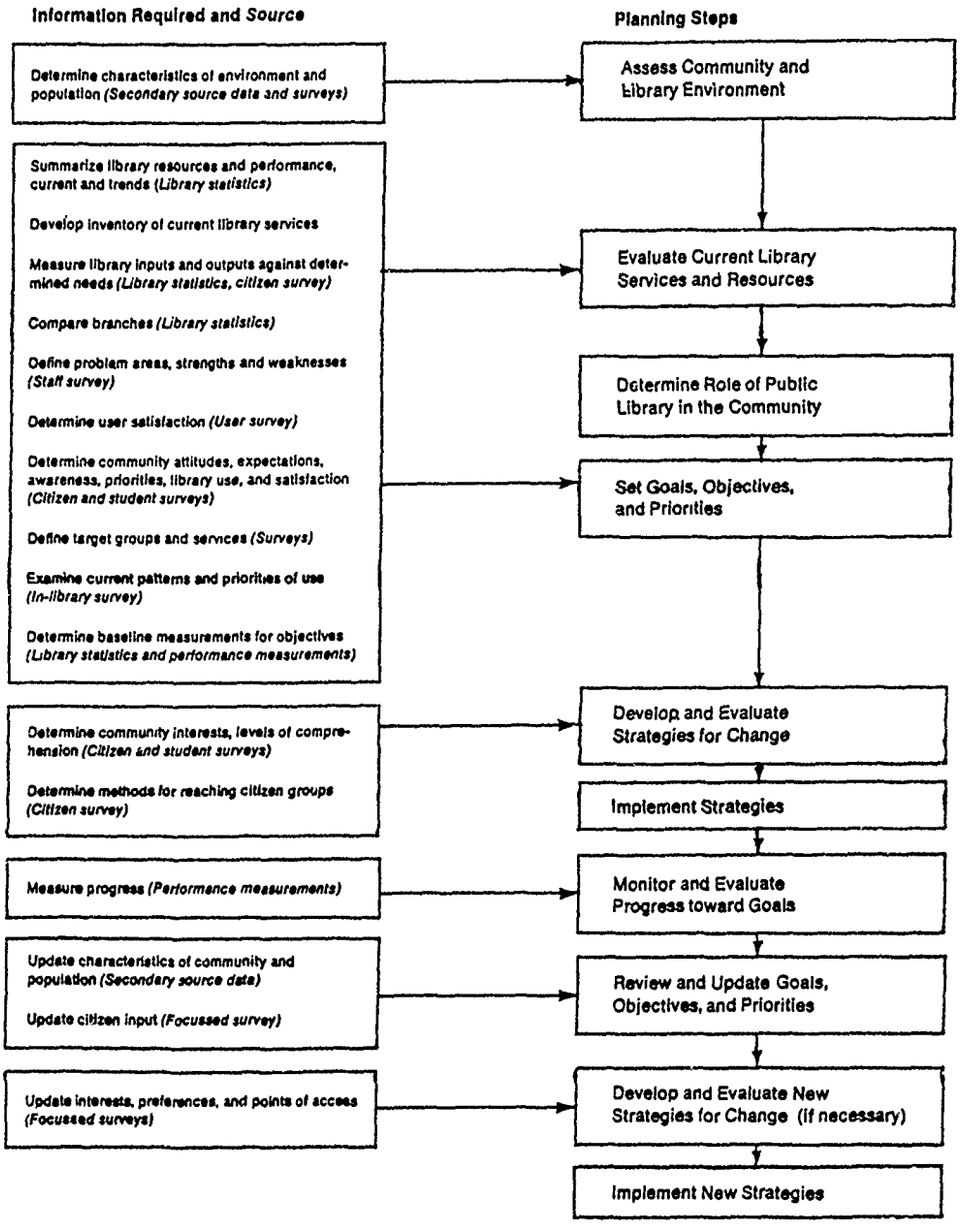


Fig.1 Information requirements for the planning process

technology must be an integral part of the entire system life cycle. Information systems have life cycles that consist of overlapping, interconnected, and alternative phases: planning and feasibility analysis, design, implementation, operation, and planning again. As shown in Figure 2, evaluation can have a role during each phase. In general, evaluation methods used during the planning and operating phases differ somewhat from those used during the design and implementation stages. The first phases make more extensive use of simulation and experimentation techniques, while the latter phases provide more opportunity for observational and descriptive techniques. The implementation phase uses both types of techniques

Evaluation research provides the basic information for designing and redesigning systems. In addition, evaluation studies have as one purpose the assessment of designs prior to implementation. In the design process, the decision-maker must begin to consider multiple alternatives under multiple conditions. The selection from alternative systems

is rarely simple with one alternative clearly dominating all others. Usually, one system or alternative technology appears to be superior with respect to one objective but not to another. The evaluator's function is to provide the decision-maker with an explicit and rational analysis. Consequently, evaluation of design alternatives often involves the use of models. Depending on the alternative, a model may involve only verbal statements of cause and effect; or mathematical models can be developed to provide necessary data. Computer simulation may be also used.

In some instances, research or feasibility analysis precedes design. When research is performed, evaluation plays an important role in observing, describing, and simulating the information environment under different conditions. These evaluation techniques provide the opportunity to consider the information environment under different conditions and perhaps anticipate potential problem areas before the actual system is operational. Experiments conducted as part of the evaluation procedure in such a research context can be performed to understand more of the phenomenon of user satisfaction by measuring as many of the different aspects of it as possible. The increased knowledge of user behavior can be used to adjust the conditions surrounding computer-based or electronic services accurately in order to increase user satisfaction.

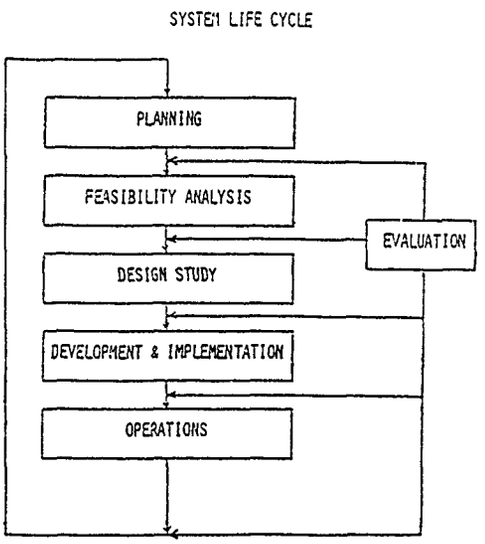


Fig.2 Evaluation as a part of a system life cycle

Once a plan has been developed and the system designed, the next step is its implementation. Evaluation is performed during this phase to check the match between the implementation and program expectations. Evaluation study results may suggest needed adjustments before the system becomes operational. The principal objectives of this evaluation are (1) to predict the performance of the system once it is made operational; (2) to reveal specific needs, if any, for modifying and correcting the system before changes become too costly; and (3) to perform a preliminary investigation of operational strategies.

As part of the planning process, decisionmaking is based on the predicted effects of alternative actions. In the operational stage of the information system, decisions are also being made on the basis of the results of past decisions. There are numerous examples of the evaluation of operational systems — evaluation is undertaken routinely in connection with quality control and in connection with the ongoing, longrange planning process that is part of most operational systems.

Evaluation studies of operational systems have one or more of the following purposes: (1) to discover whether and how well objectives are being fulfilled, (2) to determine the reasons for specific successes and failures, and (3) to uncover the principles underlying a successful program. Questions for evaluation at the operational stage include: How good is the technology? What effects does it have? Does it work as expected? The quality of the results (expected or realized) is weighted against the resources required to implement.

Information upon which to base the evaluation of current services is gathered from various sources: currently collected statistics, measures of system performance or effectiveness, and surveys. For example, the methods used in designing an information retrieval system for a group of users (e.g., in-depth interviewing and user profiles) can be used to collect new data that, when compared with earlier data, make it possible to evaluate the success of the system in attracting its target population

After the equipment has been installed and operational for six months to a year, a post-implementation evaluation might be performed. This evaluation will determine whether or not the new system meets the objectives stated during the planning, analysis and design activities. The evaluation should be as objective as possible. Consequently, consultants are often asked to perform such evaluation. The evaluation results should feed back directly into the planning process, initiating a whole new cycle.

Evaluation for Resource Management

We indicate that information center resources include staff, collections, equipment and systems, facilities, supplies and so on. Most information center budgets are based on such resources in an optional way. This is as it should be because an important part of center management is to allocate resources. Part of a resource allocation involves the allocation of funds among staff, systems, facilities, etc. Another part involves allocation within resources. For example, personnel management includes: (1) determination of information center staffing patterns (i.e., how many of the staff should be professional, paraprofessional and support and at what level for each) and (2) periodic review of information center units and individual staff members. System and equipment management includes determination of system needs and review of adherence of performance to contract specifications. Facilities management involves determining the location, size, ambience, and amount of research space, reading space, staff space requirements, etc. that are necessary; including adjustments for growth and other changes.

We suggest two basic types of measures for evaluating resources. The first measure is of input cost, which is defined

as the application of resources to various operational functions and services. Input of resources can also be described in terms of the attributes of resources such as staff competence, experience, etc., or equipment speed, reliability, etc., applied to the various functions. The second measure is of the output of resources in terms of quantities and attributes. Performance of resources, then, includes these measures and relationships between them (e.g., productivity). One can apply the results of such evaluation to financial management including annual budgeting, preparation of ad hoc modifications to the budget, and monitoring adherence to the budget.

Evaluation for Operational Function and Service Management

While most information centers maintain detailed accounting records related to resources, not nearly as many maintain data concerning operational functions and services. Yet functions and services are the essence of information centers and should be routinely evaluated. The data that are available usually concern output quantities such as the number of items acquired, number of online bibliographic searches performed and so on. However, performance evaluation must also include input costs and the relationships of input costs (and resource attributes) to output quantities (and attributes) such as quality, timeliness, etc. Input costs involve summing all resources allocated to an operational function or service, using a common unit of measure (i.e., dollars). In order to do this, the amount of resources such as staff time must be allocated to specific functions and services using cost finding methods.

Throughout the Manual we describe information centers in terms of three kinds of functions: user-related functions (e.g., reference, access to facilities and systems, access to collection and materials, etc.), operational functions (e.g., acquisitions, technical processing, etc.) and support functions (e.g., management, administration, personnel, finance, etc.). Functions are grouped in this way because each group has unique implications for evaluation objectives, measures, and methods. For example, effectiveness of user-related functions or services is measured in terms of how output affects users; effectiveness of operational functions is how output affects user-related services; and effectiveness of support functions is how well the center operates.

Evaluating Promotion, Marketing and Public Relations Functions

Even though promotion of an information center, marketing its services and public relations might properly be considered support functions, we separate them out because few information centers that we have evaluated perform these activities well if at all. At minimum, evaluation should include a determination of users' knowledge and awareness of information centers and their services. On occasion we have had center managers or staff indicate that they do not promote services because promotion will create additional work and their budget will not support this. We have tried to set forth an evaluation framework that will convince the center's parent organization or funders that the information center should be used as much as possible because use of its services will result in lower organization costs and better operations.

1.3 An Approach to Evaluation

Evaluation as disclosed in this Manual can be performed from several perspectives. The most important perspective is that of the information center with its operational functions and user-related services. However, even though evaluation may focus on a particular information center resource such as staff, automated system etc. or on a service such as online bibliographic search, the evaluation should be done in a way that the other perspectives are considered as well. In other words, evaluation should go beyond the examining of performance of resources and services to also establishing the effectiveness or consequences of them. Thus, for example if an evaluation involves online bibliographic searching one can establish service performance in such terms as cost, quantities produced, quality, timeliness, availability, cost per search, and so on. However, one can also determine the effectiveness of searching in terms of user satisfaction, amount of use, purpose of use and consequences of use on the users' work (i.e., users' productivity, quality and timeliness of work, etc.). Funders and users are interested in effectiveness as well as in the performance of operations and services, and oftentimes more so.

In Chapter 2 we set forth a framework for performing evaluation of information centers and services. In the framework we suggest a hierarchical description of information centers, including functions, services and products, activities, resources and resource characteristics. Information centers perform three basic types of functions: user-related functions (e.g., reference, user training and access to materials, equipment and facilities), operational functions that support user services (e.g., acquisitions, document processing, storage, etc) and support functions (e.g., management, finance, personnel, etc.). Each function can involve several services and products. For example, the reference function might include referral, question answering, reference searching, selective dissemination of information (SDI services), etc. For each service a number of activities (or tasks) must be performed in order to perform the service or produce a product. For example, activities for the service of reference searching include interviewing users, developing search strategies, deciding on search methods, actual search, screening output, presenting results to users, etc. In order to perform activities there must be resources such as staff, equipment, facilities, communication vendors, supplies, etc. Activities describe what is done and resources are who or what is necessary to perform activities. Finally, the lowest level in this hierarchy includes characteristics or attributes of resources such as staff competence (i.e., knowledge, skills and attitudes), experience, education or equipment quality, reliability, etc. One can address evaluation at any or all of the levels in the hierarchy.

At each level one can measure input costs and output quantities and attributes (e.g., quality, timeliness, etc.). Costs can be aggregated or summed to obtain costs at each subsequent level in the hierarchy up to the point that the cost of the entire information center is measured. Thus, one can "set a value" on input costs and output at all levels, and also establish relationships of input and output both within a level (e.g, productivity or cost per unit) and among levels. As an example of the latter, one should be able to establish the relationship of a searcher's competency to (1) input cost

(salary), (2) output quantities (number of searches performed in a year) and quality, and (3) productivity (quantity divided by cost at different levels of quality). Examples of these relationships are discussed throughout the Manual. In Chapter 2 — A Framework for Evaluating Information Centers, the framework also shows that users' work involves a hierarchy of functions, activities and resources (including information as one resource). One can also show relationships between the use of information or information service performance on users' input costs, output (quantities, quality, etc.) and productivity. This provides a powerful evaluation and information tool for information center managers.

We present a system of measures that one can use in evaluation. Included are input cost and resource attribute (e.g., staff characteristics) measures; measures of output quantities and attributes (e.g., quality, timeliness, etc); effectiveness measures (e.g., user satisfaction, amount of use, purpose of use, consequences of use, etc.); and domain measures (e.g, numbers of persons served, their information needs, etc.). Measures by themselves convey little or no meaning. Thus, we also present derived measures or indicators that yield greater meaning and usefulness. In Chapter 3 Evaluation Measures, Models and Methods, adapted from Keys to Success[4], we show that data can be presented in several forms, each of which conveys special meaning. We give an example that demonstrates how one can evaluate and derive measures to be most useful. Finally, we list the many methods (e.g., cost finding, surveys, etc.) that can be used for obtaining each measure.

Part 2 of the Manual begins with Chapter 4. This part concerns Evaluation of Information Center Operational Performance. Operational performance can involve any level of the hierarchy of functions, services and products, activities, resources and their characteristics as shown in Figure 3. At each level, as mentioned above, there is a measurable input and output. Operational performance includes all the measures and derived measures associated with input and output. The output quantities of some user related services and products (e.g., reference requests, interlibrary loans, etc.) are demand driven. That is, users determine the amounts that are to be performed or produced. The demand, in turn, is dependent on a number of factors such as output attributes (e.g., price, quality, timeliness, etc.), distance to the center, number of hours of opening, awareness of services, competition for services and so on. The extent to which these factors affect demand for services is the focus of Part Three. Part Two deals only with operational aspects of information centers. As shown in Figure 3, all levels of the hierarchy affect performance. Examples of methods for evaluating the performance of staff and automated systems are given in Chapter 5. Measures are described for 60 major functions performed in information centers and examples of staff productivity are given for each. Finally, information center funders and managers are becoming increasingly concerned with quality assurance. In Chapter 6 we provide a description and examples for a formal Quality Assurance Surveillance Program including quality control of staff-related activities. Examples are also given on how to do quality assurance.

Both operational performance and effectiveness evaluation often involve statistical survey or sampling methods. For this reason we have devoted an entire chapter to this topic, — Statistical Survey Methods for Evaluating Information Center Effectiveness (Chapter 7). For surveys we provide detailed descriptions of data collection methods, sample design, questionnaire design, data processing, data analysis, statistical analysis and presentation. Strengths and weaknesses are presented for alternative data collection methods such as self-administered questionnaires, observation of users in an information center, telephone interviews, personal interviews, indepth focus interviews and group interviews. Various statistical sample designs and sampling methods are discussed with some examples given. Sampling and nonsampling error are described with several numeric examples presented in detail including confidence intervals and sample sizes necessary to achieve desired levels of statistical precision. Nonsampling error is due to communication and processing failures. These errors result from poor questionnaire design, inadequate sample frames, nonresponse errors, response errors and other sources of error. Various means for avoiding these errors are discussed.

In Chapter 8 — Evaluating the Effectiveness of Information Centers; Chapter 9 — Evaluating the Effectiveness of Specific Information Center Services; and Chapter 10 — Evaluating the Higher Order Effects of Information and Information Service Use, we give detailed sample methods and suggested questions that can be used on a survey questionnaire. With each question we discuss why the question might be asked, problems with obtaining the data or information and typical responses that might be expected. The data are used to determine amount of use, satisfaction with services and attributes of services, purpose of use, alternative sources of services and potential cost of using them and consequences of use. Higher order effects involve how information and services affect users' work in terms of their input costs and output quality, timeliness and other consequences. Three example services are dealt with in particular detail: online bibliographic and numeric database searching, Current Awareness Bulletins and journal routing.

In Part 4 — Evaluating Information Center Cost, Benefit and Value, we show how one can link service output attributes to user satisfaction and extent of use as well as the higher order consequences of services. We also describe and provide an example of a particularly powerful method and model called conjoint measurement. This model provides a means of determining the relative utility of service attributes such as price, quality and timeliness (Chapter 11 — Relating Information Center Performance to Effectiveness). A special type of evaluation involves cost and benefit (Chapter 12). We consider costs and benefits to be unfavorable (costs) and favorable (benefits) comparisons of alternatives. Comparisons would be done for input costs, output quantities and attributes, effectiveness measures and higher order effects. An example of this kind of cost and benefit analysis is given for a resource (staff) and a service (online bibliographic search).

Finally, we devote a chapter to The Value of Information Centers and Their Services (Chapter 13). Examples are given for three perspectives on value. The first perspective is what users are willing to pay for the service; particularly in terms of their own time. This value demonstrates that users consider the information provided by information centers to be of considerable value, usually three to eight times the cost of the centers. Then we look at how much more it would cost users to obtain the information (or services) if there were no information center. This value is also usually considerably higher than the cost of the center. Finally, we establish measures of cost avoidance lost without services. This value is usually even higher.

We stress that the evaluation measures, models and methods presented in this Manual are not the only ones that evaluators use. The reader is referred to other approaches demonstrated by the bibliography at the end of the Manual.

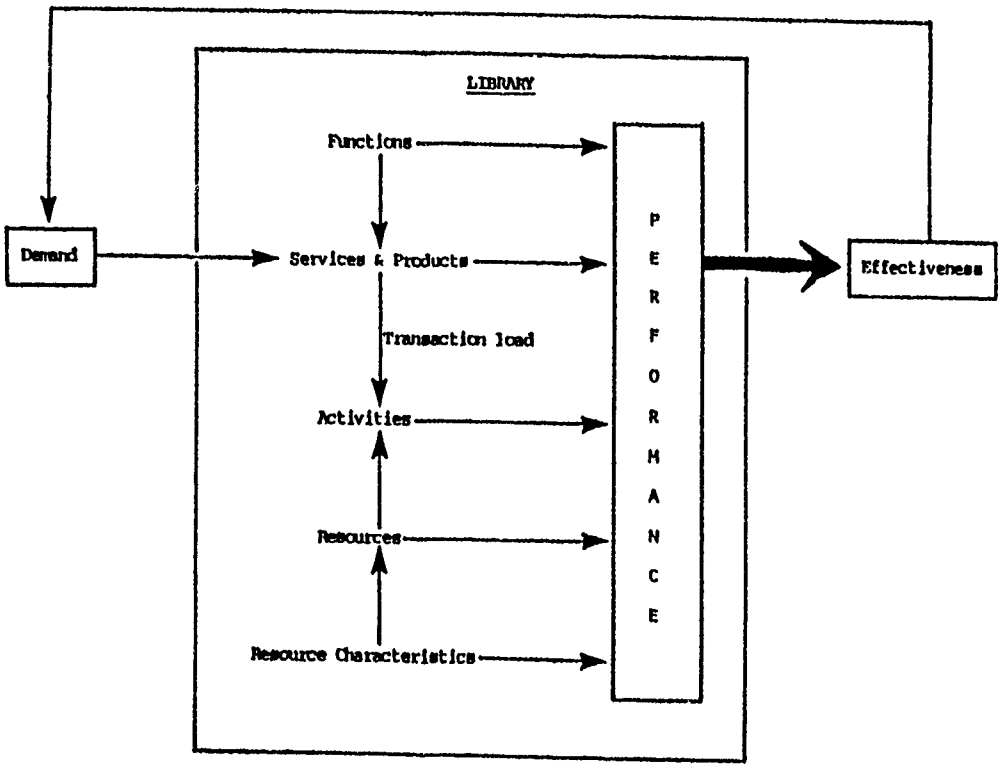


Fig.3 Conceptual framework for library staffing studies

Chapter 2

A Framework for Evaluating Information Centers

2.1 Background

Several studies by King Research [7] and others in recent years [8,9] have clearly demonstrated that information is extensively read and used by professionals such as scientists, lawyers, engineers, administrators, and so on. Readings of such information are used for many purposes, including research, writing, proposal development, management, marketing, professional development, education, and so on. Each purpose of use has some value, otherwise professionals would not devote their scarce time to obtaining, reading and using information. One contributor notes value of information is in cost avoidance; for example, by not having to repeat research for which results are already available or by avoiding a costly environmental control penalty. In the literature and through one's own experience, anecdotal data concerning such savings are available, particularly concerning very large savings. The King Research studies mentioned above have attempted to estimate the total extent of such cost avoidance by observing incidents of savings from a random sample of scientists and determining the consequences of their readings of articles, books and technical reports. All readings in 1984 of articles, books and technical reports were estimated to yield $300 billion in savings to the scientific community in the U.S.[10]. This is not surprising when one considers that if scientists and engineers were denied access to information, it is doubtful that they could accomplish their work. Furthermore, in addition to such savings attributable to information and its use, we have observed several indicators which show that reading also contributes to improved quality, timeliness and productivity of the user's work.

Another way to emphasize the importance of reading and keeping up with current research findings is to consider the rapid growth of science and technology. The amount of recorded literature doubles about every 15 to 17 years. This means that all the scientific knowledge recorded throughout the history of mankind up to 1970 has now more than doubled since that time and probably will double again by the end of this century. This means that engineers or scientists, upon graduating from college, will be exposed to only one-sixth of the knowledge that they must master during their careers. Because of the necessity to keep up with the literature, scientists, engineers and other professionals read a large number of articles, technical reports and books. Our research shows that all professionals in the U.S., such as scientists, engineers, medical practitioners, lawyers, educators and businessmen, read over one billion journal articles a year, and engineers and scientists account for nearly one-third of that amount[10].

Information Centers that serve companies, government agencies, academic institutions, other organizations, and individuals have been undergoing tremendous change. At one time, such centers were concerned largely with books, then they added serials and periodicals. Now they must also store and provide access to government publications and internal research, technical and other reports and, because of new technology, they provide access to audiovisual materials, equipment and software.

A number of other factors are changing the needs and requirements of information centers and their users. They must provide access to an accumulating body of recorded knowledge. As mentioned above, since 1970 the amount of knowledge recorded throughout the history of mankind up to that time has more then doubled. One of the unique roles of information centers and documentation centers is to provide access to all of the published literature. Naturally, they cannot each hold all of the literature ever published, nor even all published in a particular subject area, but they do provide access to it through interinstitutional borrowing from other centers or through document delivery services. Thus, not only do information centers have to cope with an ever increasing amount of new literature, they currently have to provide access to over twice as large a body of literature in 1990 as they did in 1970.

Information Center users are becoming more information intensive in general and are using such centers more frequently now than they have in the past. For example, from 1977 to 1984 we observed from national surveys that engineers and scientists have increased the proportion of their reading from information center copies of journals by nearly 50 percent[10]. Furthermore, they use many information services now that were not even known 25 years ago such as online retrieval of bibliographic and numeric data. They also provide other special information services such as translation from foreign languages.

Information Center users are increasingly exposed to new information technology. There has been a great deal of discussion, in the literature, of how as the user becomes more "computer and information literate," the information center will no longer have a role to play as intermediary However, the opposite is observed in most environments. Admittedly, users of information do perform some of their own information searches, particularly when they have become comfortable with available systems. However, as they do more searching, they recognize that more of their scarce time is being taken up with information searching and retrieval activities. They learn that there are a large number and variety of sources of information to choose from, and that the sources change over time in terms of coverage, procedures for use, quality, etc. Once they recognize the complexity of information searching and retrieval, they begin to return to the information center as an intermediary, particularly for their more complex requirements. However, since their experience has given them a better awareness and understanding of information systems, they are better able to articulate their information needs, and they are more sophisticated in terms of their expectations of and demands on information center services.

Because of the evolution of the information-seeking behavior of professionals, and the recognition of the importance and value of information and information services, many organizations are evaluating their information services to ensure that sufficient services are being provided and that optimum return-on investment in these services is being achieved. This chapter presents an evaluation framework which can be used to: (1) assess the information-seeking behavior of professionals, (2) establish indicators of extent to which use of information affects their work, (3) evaluate the performance of information center operations and services and (4) determine the extent to which information center services contribute to the use, usefulness and value of information. By determining the extent to which services contribute to users' work, information managers can perform a truly comprehensive evaluation of operations and services. Such comprehensive evaluation establishes not only measures of input costs and output quantities and attributes of all operational functions and services, but also the relationships between (1) input cost and output and (2) between output attributes and the extent to which services are used and the effects of the services on users' work. We have found that information center funders and high level managers relate very well to this way of evaluating operations and services.

2.2. Framework for a Comprehensive Evaluation of Information Centers and Services

Below we present an approach to data collection and analysis for information center evaluation planning and management through an example. The framework for this example is displayed in Figure 4. There are three dimensions to the framework. One dimension involves three perspectives on evaluation: the information center service perspective (e.g., online searching), user perspective (e.g., a scientist conducting research), and the user's organization perspective. Decisions made based on any one of the three levels will effect decisions based on the other two perspectives. For example, if information center management decides to improve its online searching by hiring more competent information specialists, the quality and timeliness of the searches should improve. Evidence shows that improved service should result in (1) more searches being performed, (2) users' time being saved, and (3) improvements in output of users' work. Since users contribute to the organization's goals and mission, any change in their work will have some effect on the goals and mission. On the other hand, if users change the nature of their work or alter their information-seeking behavior, their information needs and requirements will change thereby affecting the information center's ability to serve them.

We look at all three perspectives as involving functions (or services) which consist of activities necessary to perform the functions and resources that are necessary to perform the activities (see Chapter 3 for a more detailed description of these levels). This is the second dimension of the evaluation framework in Figure 4. From the center's perspective, online searching is a service; activities might include interviewing users, negotiating the search, developing a search strategy, conducting a search, reviewing results, providing results to users, etc. Resources could include staff, terminals, photocopiers, vendor services, reference materials, etc. From the user's perspective, functions might include research engineering, management, legal work, professional development, etc. Resources would include the users' time, information, support staff, equipment, etc. used to perform these functions. From the organization's perspective, functions might be R&D, manufacturing, marketing, etc. and resources are the sum of staff, facilities, equipment, etc. applied to the functions.

Each function or service, activity and resource has an input cost and an output associated with it. The inputs and outputs are the third dimension of the evaluation framework. We refer to the application of these resources (or resource funds) as input costs. The output of the functions (or services), activities or application of resources is some product or service. For example, the output of online searching can be printouts or search results communicated orally by the searcher. The output of users' work may be documentation of their work in the form of laboratory notes, technical reports, proposals, presentations, etc. Thus, information serves as both input and output for users' work as discussed in more depth in Chapter 4. In addition to identifiable output products or services, the outputs can also be characterized by attributes such as quality, timeliness, etc. of the services or work performed.

For the information center example in the Figure 4, the service is online searching and resources are searchers, terminals, search tools, support staff (e.g., to do photocopying, typing, etc.), communication, search systems, photocopying, etc. Associated with the resources are costs which are dependent on the attributes of the resources (arrow [a]). Output quantities are related to costs. Likewise, output (in terms of number of searches conducted, quality and timeliness) depends partially on the attributes of the resources (arrow [b]). The relationships between resource attributes and input cost and output performance are quite clear. For example, better searcher competencies (i.e., knowledge, skills and attitudes) usually cost more (in salaries) but should also yield more and/or better search output. Performance of online searching can also be measured by cost per search or productivity (searches per hour or dollar cost). These relationships are also designated by arrow (c). In considering productivity, we feel that it is best to incorporate quality and timeliness as well as quantities produced, for example, by measuring cost per search at discrete levels of quality and timeliness or at least above an acceptable level of quality and timeliness.

Similarly, laboratory research conducted by a scientist is given as an example of an activity from the user perspective. To perform this research activity, scientists or other professionals must have such resources as their own time, equipment, instrumentation, facilities, support staff and information. The amount and quality of information used by the scientists depends partially on the output attributes of the online search. This relationship is designated by arrow (f). In turn, the amount, quality and timeliness of information will affect cost of performing the research activity (arrow [g]) and output amount, quality and timeliness of research (arrow [h]). Productivity of the scientist is shown by (arrow [i]). Thus, the output of the information service should affect the productivity of scientists. Similarly the outputs of scientists' activities should affect the input costs and outputs of their units, and hence, the users' organization as a whole (arrows [k], [l], and [m]). Furthermore, the organization's total input cost is affected by the center's cost (arrow [d]) and user's cost (arrow [j]).

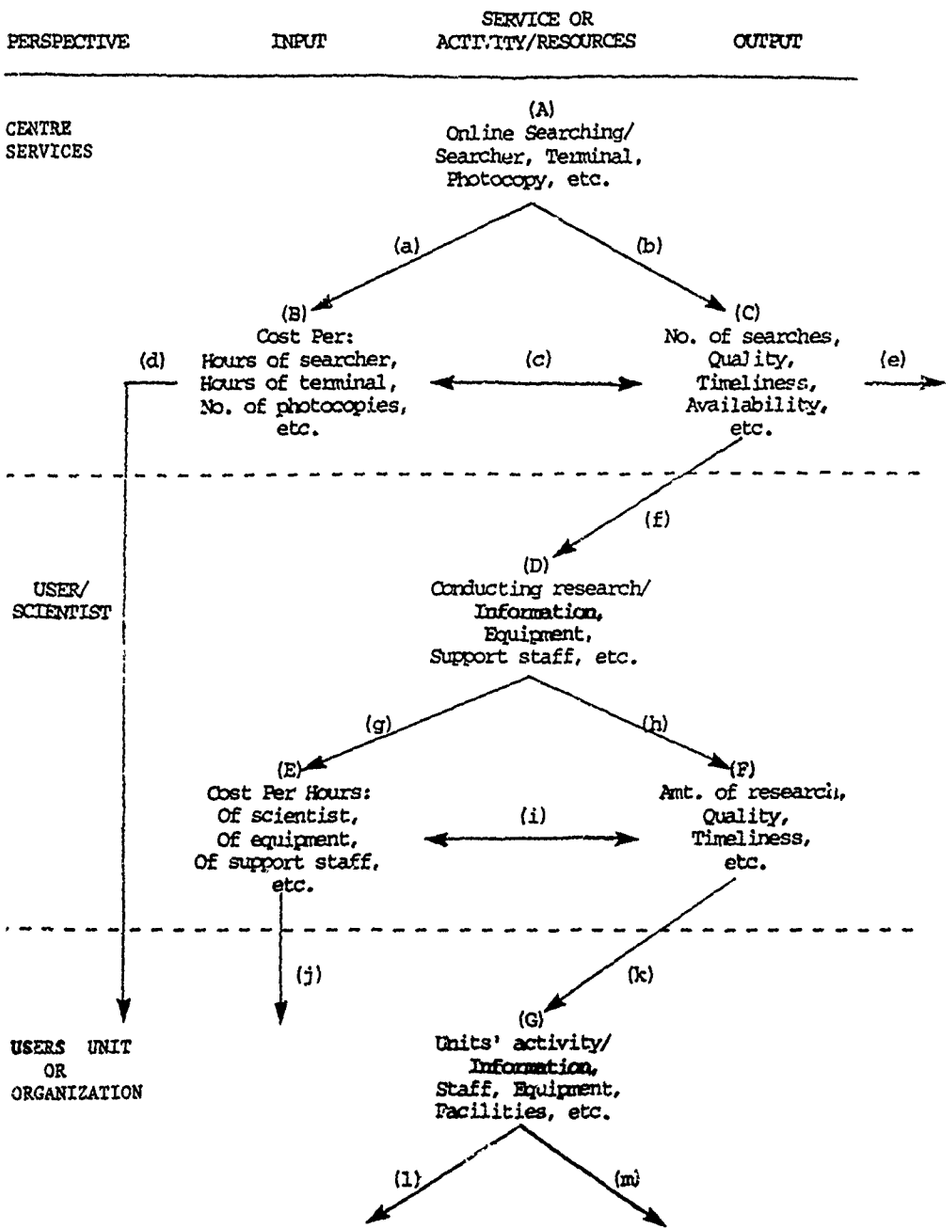


Fig.4 Framework for evaluating

Measures

For each information service one can define subactivities and resources that are used in providing the services (A in Figure 4). In addition to the numbers or amounts of the resources, one can characterize them in terms of attributes that are likely to affect input cost (B) and output quantities and attributes (C). Such attributes include staff competencies (knowledge, skills, attitudes) or indicators of competencies such as educational background, training and years of experience; equipment capabilities such as communication rates, storage capacities, reliability, etc.; photocopy or reproduction quality; microfilm viewer readability; and so on. Cost data can be subdivided into fixed onetime, fixed recurring and variable elements and by direct and indirect costs (see Chapter 4). Output (C) can be identified and measured in terms of quantities produced, quality (probably more than one measure per service), timeliness (probably both by response times and by the difference between negotiated time and actual time the service is delivered) and any other attributes that might appreciably affect user satisfaction and continued use of the service. We have found that it is sometimes useful to set an acceptable level of output quality and timeliness so that one can estimate the frequency of unacceptable performance and, perhaps, later implement a quality control program for some services (see Chapter 6).

In particular, we suggest that evaluators should identify the functions (or activities) performed by users and determine the extent to which they are performed (i.e., in terms of hours spent) by users (D). For each function, the resources used are determined, particularly in terms of the types of information provided by the information center. One can also collect data on attitudes regarding the relative importance of information compared with other resources used in performing the various user functions. The cost (E) to users of identifying, acquiring and reading information can be measured. These costs include user labor, support labor, equipment, purchases of materials, information, and so on. One can also measure indicators of user output (F) associated with each function. Such output includes number of proposals or plans written, research reports (e.g., laboratory notebooks) prepared, journal articles or other publications written, consultations performed, and so on. In addition, for critical incidents one can estimate the contribution that readings (of books, journal articles, technical reports, etc.) make to savings in labor and equipment, improving quality or speeding up completion of an activity, and so on. Finally, to the degree possible, one can measure how user performance, in turn, affects the unit's or the organization's total input costs and output.

Models

One can establish correlations and other quantifiable relationships between information center input costs and outputs; service outputs and user input costs or outputs; user input costs and user outputs; and user outputs and unit/organization input costs. These relationships or links can be developed largely through correlation, multiple regression and conjoint measurement models. Those models can be applied using surveys (see Part 3) because the surveys yield several hundred observations of critical incidents. Conjoint measurement permits one to determine the relative contributions that service performance attributes make over various levels of the attributes. For example, one can determine how much use would be lost over various combinations of search quality and speed of response (see Chapter 11).

Other independent variables are introduced to account for other sources of variation. Our experience has shown that the measurable relationships become weaker as the ability to observe or measure becomes more difficult. Nevertheless, we have found positive correlations in most such instances. Cost and benefit analysis is performed by comparing each information service to its least expensive alternative (or alternative that is most likely to be employed by users). Then, by application of the models, one can compare the current service with the alternative in terms of: service input costs, service outputs, user input costs, user outputs, and so on.

2.3. Definition of Terms Used in the Manual

In recognition that evaluation terms have different definitions and meanings in various professional fields or specialties, we offer the following definition of terms. These definitions are provided to ensure a common basis for reading this manual.

- *Information Center* — An information center is defined as a unit whose principal function is to provide information services on products for the benefit of endusers and/or intermediary organizations. Information centers include organization libraries (i.e., special libraries, academic libraries, etc.), clearinghouses, technical information centers, special publication units, and so on.
- *Operational Function or Service* — Information center operational functions and services may be defined at several levels. Examples of types of functions and services include (1) technical functions such as ordering or cataloging information materials, etc., (2) user-related services such as reference or access to a collection, or (3) support function provided by administrators. Operational functions and services can themselves be subdivided into the discrete activities necessary to perform them (e.g., contacting a patron, negotiating what is needed, performing online searches, reporting results, etc.). Each activity may require several resources (e.g., staff, equipment, etc.). Products are usually the physical output of services (e.g., print-out of an online search), although every service does not necessarily have a product.
- *Input* — Several input resources are necessary to offer/perform services. These include capital, staff, equipment, facilities, information, supplies, administrative and support staff, etc. Input is considered the application of these resources. Each resource can be measured in several ways; for example, staff can be measured in Full-Time Equivalents, number of persons, hours of work, or cost (salary, fringe benefits, overhead).
- *Output* — Measures of output of information services include quantities of output (e.g., number of items acquired, number of items circulated, number of searches performed, etc.) and output attributes such as quality of service, timeliness of services provided, availability and accessibility of information center materials, equipment, staff and facilities, etc.
- *Productivity* — Productivity is a measure of the ratio of output divided by input. It is formally defined as "a

concept that expresses the relationship between the quantity of goods and services produced—output—and the quantity of labor, capital, land, energy, and other resources that produced it—input." (U.S. Department of Labor, Bureau of Labor Statistics, *Productivity and the Economy: A Chartbook* (Bulletin 2172). Washington, DC: Government Printing Office, June 1983.) Productivity is a derived measure which links input and output. The weakness of the traditional measure of productivity is that there is an interdependence among amount of input resources, input resource attributes, output quantities produced, and output attributes such as quality, timeliness, etc. For example, a center staff's competency will affect both input (amount of time and cost necessary to perform a service) as well as output (amount, quality and timeliness of service). There is usually an inverse relationship between input amount of services produced and service output quality, timeliness, etc.

- *Performance* — Performance is an indication of how well a service or activity is performed. It can be measured in terms of the input costs and output quantities produced, quality, timeliness, availability, accessibility, etc. Other indications of performance are productivity, efficiency (i.e., how close services or activities come to achieving some maximum), etc. Output attributes relates to the effectiveness of services (see below). Measures of productivity, efficiency, etc., are measures which are internal to the service and they can be used to help manage an information center.
- *Effectiveness* — Effectiveness is measured from the perspective of the users of information center services. Examples of measures of effectiveness include user satisfaction with a service, repeated use of a service and number of times a service is used (first order effects). Higher order effects include effect of services on the user's research and consequences of the user's research, improved productivity of the user's operation or research, etc. Presumably, improved service quality, timeliness, availability, etc. should result in greater user satisfaction, repeated use and the number of times a service is used. Thus, information center service output attributes affects the effectiveness of the service.
- *Cost and Benefits* — The costs (i.e., detriments) and benefits of an information center service are the unfavorable and favorable comparisons of a service with alternative services, in terms of differences in input, output, performance and effectiveness. For example, the value added by a service could be that the service costs less than an alternative service, and/or the service is better than the alternative in terms of performance or effectiveness. Such an alternative to a service might be for users to perform the work themselves or to engage a consultant or company to provide the service to them.
- *Indicators* — Sometimes it is not possible to measure input, output, performance or effectiveness directly. Thus, indicators must suffice. Indicators of a center staff member's competency are degrees held, university attended, professional awards given, elected position in a professional society, etc. Indicators may be needed for higher order effects. For example, one indicator of research output is number of laboratory notes or articles written which report the research.
- *Factors That Affect Information Center Service Input, Output, Performance and Effectiveness* — Factors that affect input might include staff characteristics, equipment attributes, etc. Examples of factors that might affect output or performance (in addition to amount of input resources) are management (policies, capabilities, attitudes, etc.), physical environment, attitude or capability of users, etc. Factors that might affect effectiveness (in addition to output performance) are user awareness of, attitudes toward, or perception of an information center, a charge for the service, distance to the service, communication constraints, etc. Some factors are internal and, therefore, controllable. Other factors are external and less controllable by information center management.
- *Linkage of Information Center Services' Input to Output, and Center Service Performance to Effectiveness* — Linkage is achieved through correlation and/or mathematical models which show that (1) output quantities and attributes are related to input resources in addition to other factors, (2) first order effects (e.g., frequency of use of a service) depend on output attributes in addition to other factors, and (3) higher order effects depend on first order effects.

Chapter 3

Evaluation Measures, Models and Methods

3.1 Background

The heart of the evaluation of information centers involves measures, models and methods. In this chapter (partially adapted from *Keys to Success*) we discuss some concepts of these three components of information center evaluation. As stated earlier, the concepts we present are by no means the only way of looking at evaluation nor are the measures, models, and methods the only ones used for evaluating information centers and services. However, over the years the approach presented here has been found to be useful for evaluating a large number (about 300) of information centers, libraries, clearinghouses, publications, online services, centralized and decentralized automated systems, library networks, and a host of other information services.

Evaluation measures are the "values" measured or placed on information centers operations and services. In Chapter 2 we presented a particular framework for evaluation. Here we present examples of measures related to (1) input cost (i.e., amounts of resources or money applied to operational functions or services and attributes of these resources), (2) output (i.e., the quantities of operational functions or services produced and attributes of the output), (3) effectiveness (i.e., satisfaction with services, amount of use, purpose of use, consequences of use), and (4) domain (i.e., descriptions of the environment served by the information center).

The individual measures alone do not convey much meaning. For example, knowing that staff input costs are $140,000 for online bibliographic search services is not particularly useful without some context such as timeframe, number and experience of staff, number and type of searches performed, etc. For this reason, we present some relationships among measures which we refer to as models. These models provide more useful tools for evaluation and decisionmaking than measures alone. The simplest of relationships are ratios (e.g., number of items produced per hour of labor) or averages (e.g., average number of searches conducted per user). More complex models include statistical correlation, multiple regression and conjoint measurement, and operations research models including queuing, Markoff chains, etc. As Meadows[1] points out, there are several other types of models as well, including non-quantitative models. The reader is referred to his paper and those of others to become familiar with the range of models available for evaluation.

In this Manual we focus on three particular methods: (1) cost finding for measuring input costs and output, (2) quality assurance surveillance, and (3) statistical surveys. Cost finding involves nonexact, but very useful methods for measuring costs and output quantities. A chapter is devoted to measuring output quantities and attributes such as quality and timeliness in order to assure that acceptable levels are continually achieved. We also devote several chapters to statistical surveys since they are used to measure the effectiveness of information centers and services. Finally, in Part 4, we discuss cost and benefit analysis and measures of the value of information centers and services. The remainder of this chapter discusses some of the concepts of evaluation measures, models and methods.

3.2. Evaluation Measures

Definition of Measure

For the purpose of this manual we define "measure" as follows:

Measure: Generically used to mean any process for describing in quantitative values; things, people, events, etc. Measure also means the value being measured.

In the Manual we use measures as a generic term which reflects a number of commonly used measures in evaluation such as:

To *measure* distance (e.g., the number of feet or meters of shelving) or the square feet (meters) of floor space.

To *count* the number of people on the staff or number of visits to an information center.

To *record* the duration of the time required to respond to online search requests or the amount of time required to actually perform a search.

To *observe* what users or staff are doing at a point in time such as doing research at study tables or reshelving documents.

To *survey* users to determine their satisfaction with services or their number of uses of a service in the last month.

To *compute* costs of resources or services.

In this manual we most often use the term "measure" to mean the values being measured by the processes of measuring above. There are two components of measures:

Numeric Values measured such as *12* staff members, *12* dollars, *12* hours, *12* searches performed.

Units of measure such as 12 *staff members,* 12 *dollars,* 12 *hours,* 12 *searches performed.*

Part of the definition of evaluation measures includes the context within which the measures are taken. Such a context should include at a minimum:

Method used. For example, if a survey is used it should be described in some detail somewhere in the report and mentioned in any tables presenting the data so that one can refer to the description.

Context of units measured. For example, if staff counts are given it is important to specify what types of staff (e g., professionals, paraprofessionals, clerical, etc.,) whether the count is of all staff (i.e., a head count), full-time equivalents, etc.

Time period in which units are measured. For example, if cost finding is used to estimate staff cost of searches, the time in which cost allocations are made should be specified (e.g., fall of 1990 or March 1990).

All of the above should be included in describing or reporting measures.

Generic Types of Measures

Evaluation of information centers involves four generic types of measures including *input* cost measures, *output* measures, *effectiveness* measures, and *domain* measures. The first two types of measures (input cost and output) involve information center operations and they, individually or together, help to establish the performance of resources, activities, services, functions or the entire information center. Such measures include the amount and attributes of resources applied to services and output quantity and attributes of services. Effectiveness measures are those involving the effects of center services from the perspective of users such as amount of use, purpose of use, consequences of use, etc. Domain measures involve descriptions of the environment or context of the information center. Such measures include the total number of persons in the service population, their information needs, etc.

Information center performance is largely controlled by center management. For example, a management decision to hire online bibliographic searchers with subject knowledge affects input cost (because their salaries are high) as well as output quantities, quality, timeliness, etc. If input costs or output are not satisfactory, management can correct the situation through training or firing and re-hiring, etc. However, management has less direct control over center effectiveness because there are so many external factors that affect the extent to which services are used and the consequences of that use. However, management can react to these factors with proper knowledge of them and how they affect use. Managers have almost no control over domain measures. Nevertheless, knowledge of them is very important to center managers (and staff as well). Examples of the four types of measures are given below.

Input Cost Measures

Input cost measures include:

- Amount of resources applied to operational functions and services.
- Relevant attributes of resources applied to services.
- Amount of money applied to services: where money (i.e., dollars, pounds, francs, etc.) is a common unit that can be applied to all resources.

Examples of quantities and attributes of resources are as follows:

RESOURCES	QUANTITIES	ATTRIBUTES
Staff	No of people (head count), no of hours worked full time equivalents (FTE's)	Level (i e , professional para professional, clerical/support), competence (knowledge skills, attitudes), education, years of experience
Collection	No of titles in collection, no of titles purchased, no of items/pieces purchased	Type of material (i e , books, periodicals, audiovisuals technical reports), subject classification media (i e , print/paper, microform, electronic), age
Equipment and Systems	No of pieces of equipment	Type of equipment, application, age, reliability, speed make and model
Facilities	Area (floor space), no of floors, no of sites	Functional areas, main vs satellite branch, and special attributes such as handicap entrance, ambience, etc
Financial/Cost	Dollars, pounds, francs, etc	Allocations of funds, application of funds, direct vs indirect fixed vs variable (see Chapter 4)

Input costs of operational functions and services are the sum of all resources applied to the functions or services.

Output Measures

Corresponding to input costs are output measures which include:

- *Quantities of output* of services and operational functions are measures of the numbers of transactions or items provided. Such quantities of services can include, for example, number of searches performed, number of documents provided or made available, or number of documents photocopied, etc. Examples of operational function outputs include number of items catalogued, number of items ordered, and so on. Quantities of output should correspond to the same time period and attributes of resources as were used to measure the service input costs. Each unit of output has inherent attributes associated with it such as quality, timeliness, availability and accessibility that should be measured.
- *Quality* is a generic output measure which describes the grade or "goodness" of information center services. Quality is measured less frequently for services than timeliness, availability and accessibility. Furthermore, it is difficult to identify and measure quality attributes for many services. Examples of quality measures include relevance of search outputs, accuracy of cataloging, or level of excellence of activities. These measures must be carefully defined. Sometimes quality cannot be measured directly, in which case, scale values, (e.g., a scale of 1 to 5) are used. Quality should be measured for specific units of output, (e.g., an item cataloged, a reference search, etc.). However, all transactions or units of output need not always be measured since sampling methods can be used.
- *Timeliness* of user services involves an elapsed time between request and receipt of the output of a service. The elapsed time can be measured in minutes (e.g., with circulations) hours or days. For some services (e.g., online database searching, interlibrary borrowing, etc.), it is useful to establish a time by which users require a response and measure the difference between the elapsed time and the required time. For example, a user may require search results in three days to prepare a report. If the elapsed response time is four

days the difference is one day late. Another user may require the results in five days. If the elapsed response time is four days, this user will be much happier than the user who required the response in three days. Just as with quality, timeliness should be measured for specific units of output.

- A principal measure of *availability* is number of hours of service, (e.g., number of hours of service per day or per week), or number of person hours of service, (e.g., number of hours of service times the number of persons providing the service during those hours). The spread of hours of availability over a week, (e.g., morning, afternoon, evening and weekend hours) is also a measure of availability. Another example of availability is the specified loan period of materials. Availability is usually measured for a service, but not as a unit of service output.
- One measure of *accessibility* is the distance of the service (or information center) to the user. Distance can be measured in feet or floors in a building, or in terms of a surrogate measure such as time (e.g., minutes). Waiting time (e.g., in service queues) is an important measure of service accessibility. The time taken by users to get to an information center and waiting for services is a portion of the "price" paid by users to use center services. The more users are required to "pay" in terms of their own time, the less likely they are to use the services. Accessibility to collection, equipment, etc. is of particular concern to users. Materials may be inaccessible if kept in a remote storage or compact storage. Public access terminals may be inaccessible as a result of extensive use. Finally, accessibility is an important consideration for people with disabilities. Physical accessibility can be assessed in terms of the existence of special facilities such as wheelchair ramps or by rating the degree of accessibility using scales (1 to 5). Psychological barriers to using an information center can also create accessibility problems. Perceptions of accessibility to the center and its services on the part of the population served will have an effect on the amount of use that is made of them. Distance is observed for the entire center or for specific services by individual users. Waiting time involves specific service transactions, whereas remote storage, etc. involves certain items of collection or equipment.

Effectiveness Measures

Effectiveness measures include:

- The *amount of use* of an information center or any of its services is an important measure of effectiveness. The more a center or its services are used, the more effective it is. The amount of use of a center can be measured by the number of visits to it, although there are other forms of use such as telephone calls to a reference service. Amount of service use can be measured in several ways. Collection use can be number of items loaned or amount of reading. Uses of services should clearly define and specify what is meant by use, such as requests for reference service, or number of items provided, use of photocopying equipment (i.e., an occasion of use, an article photocopied or a page photocopied). For some services, the amount of use is the same as the amount of service output. These amounts are usually demand-driven. That is, the amounts are largely determined by users and the extent to which users will use these services depends a great deal on output and service attributes such as quality, timeliness, availability and accessibility. On the other hand, the amount of use of some services such as access to materials do not correspond to output quantities, (e.g., number of items in the collection).

  Just as with operational function and service outputs, each service and unit of use has associated attributes that can affect to the extent of use. These attributes include users' perceptions of service performance, their expressed levels of satisfaction with services, their indicated importance of the services to them, the purposes for which services are used, and consequences of their use. These attributes are very relevant to the use, usefulness, and value of information centers. Additional effectiveness measures are as follows:

- *Users' perceptions of services* and service attributes can be measured by their rating services and attributes. Service ratings can be measured in general or for specific attributes of service. For example:

  General service performance rating of reference services:

Very Bad	Bad	Neither Good Nor Bad	Very Good	Good
1	2	3	4	5

Specific attributes such as relevance of response:

Not at All Relevant	Minimally Relevant	Relevant	Very Relevant	Extremely Relevant
1	2	3	4	5

  Some service attributes are readily observable and measures of users' perceptions are not always required. For example, response time should be known by both the center and the user and, therefore, measurable by recording at the center and/or reporting by users (on a survey questionnaire).

- *User expressed satisfaction* with information needs and service requirements determine to a large degree the extent to which services will continue to be used. It is difficult for users to express satisfaction with how well services meet their information needs and service requirements, but they can quite easily rate their satisfaction on numeric scales. For example, users can rate their satisfaction with timeliness of response of a reference search as follows:

Very Dissatisfied	Dissatisfied	Neither Satisfied Nor Dissatisfied	Satisfied	Very Satisfied
1	2	3	4	5

  Satisfaction probably should be measured in the context of either specific needs or specific requirements. For example, one should measure satisfaction with reference response time and/or with relevance of response.

- Another measure related to satisfaction is the *importance of information needs or requirements* or of a service. High satisfaction with low importance for timeliness has significantly different meaning (at least in terms of repeated use) than high satisfaction with high importance. Importance can (and should) also be measured for services in general and for specific attributes of services. Importance can also be measured with rating scales.

  Importance of photocopying services:

Very Unimportant	Unimportant	Neither Important Nor Unimportant	Important	Very Important
1	2	3	4	5

  Importance of amount of charge for coin-operated machines:

Very Unimportant	Unimportant	Neither Important Nor Unimportant	Important	Very Important
1	2	3	4	5

If interested in comparing across services an information center can have users rank services in order of their importance.

One can rate importance of levels of availability such as loan period:

Importance of Having Loan Period More Than	Very Important	Important	Neither Important Nor Unimportant	Important	Important
One Week	1	2	3	4	5
Two Weeks	1	2	3	4	5
Three Weeks	1	2	3	4	5
Four Weeks	1	2	3	4	5

- There are many measures of use of information center materials and services, each of which has some implication for the consequences or value resulting from the use of the centers.

- We often characterize *purpose of use* by type of work or other function for which the information or services are used. Such type of work might include research, engineering, legal work, medical care, management, financial work, marketing or sales.

- *Consequences of use* can be expressed in terms of how information provided by information center or services affects users' work (i.e., input cost, output quantities, quality, timeliness, etc.). Even through one cannot always place values on such consequences of use, it is useful to consider them and at least make statements about these consequences.

Domain Measures

Domain measures include:

- Total number of persons in service population: head counts, FTE's

- Total number of persons in user population: head counts

- Attributes of persons in target and user populations: field of specialty (i.e., chemistry, law, engineering, medicine), work roles (R&D, administration, legal work, operations, marketing, etc.), age or years of experience, degree level.

- Information behavior: amount of reading, information media used, sources of information used, amount of writing, number of presentations, number of consultations, etc.

- Information need: number of persons having need by type of information needed (research results, census data, legal briefs, etc.), purpose of use of information (see above).

- Importance of information as a resource: rating of importance of information on scales of 1 to 4, 1 to 5, or 1 to 7.

3.3 Evaluation Models

Evaluation measures by themselves do not always provide sufficient information for operational decisionmaking, design, planning, and so on. For example, knowing the costs of services or the output quantity is not nearly as meaningful to consider as the two measures together; i.e., cost per transaction or number of transactions per input cost (i.e., productivity).

An example to demonstrate how relationships between measures can reveal useful management information is given below. In the example assume that information center staff is observed for a period of two weeks and that 50 staff members spend anywhere between one and 50 hours providing a service (e.g., document ordering) or operational function (e.g., acquisitions). Hypothetical results of staff hours worked and number of units of output produced (50 staff members) are given below:

EXAMPLE OF VALUES FOR DETERMINING RELATIONSHIPS BETWEEN STAFF INPUT AND OUTPUT
50 STAFF MEMBERS OBSERVED OVER TWO WEEKS

Hours Worked (x)	Units Produced (y)	Hours Worked (x)	Units Produced (y)
18	102	31	121
19	116	10	25
48	345	43	231
8	28	36	191
25	140	14	65
29	182	24	121
4	12	2	1
46	281	47	265
37	235	32	146
12	46	12	36
16	68	17	60
34	210	35	190
36	230	41	211
7	21	5	17
44	270	24	121
27	138	27	140
6	16	1	2
42	211	22	76
38	268	33	185
19	128	16	61
29	195	13	45
34	205	46	210
50	340	45	260
2	5	3	4
23	136	22	75

The total number of hours worked by these 50 staff members during the two-week period is 1,254 hours and they produced 6,787 transactions or units. Neither of these two measures has much meaning alone, nor do averages of hours per staff member (25.1 hours per person) or units per staff member (135.7 units per person). However, relating the two measures such as average number of units produced per hour begins to have some useful meaning (5.4 units per hour). If the number of units produced by the information center is increasing each year from about 176,000 units in 1990 to 220,000 in 1991 the center must budget for about 8,148 more hours to do the work (i.e., 44,000 additional units divided by 5.4 units per hour). Or if the average hourly rate is $12.00, the budget increase would be about $97,800 (i.e., 8,148 hours times $12.00 per hour).

The relationship can be displayed in graphic as well as tabular form as shown in Figure 5. Again, the data displayed as such do not convey a great deal of meaning. Using linear regression the relationship provides some more quantitative information through the following equation:

$$y = a + bx$$
$$= -25 + 6.4x$$

where y is units produced and x is number of hours worked. This equation is represented in the figure by a straight line. Using the equation one can approximate or estimate the number of units one would expect from a staff member working between 1 to 50 hours in a two-week period. For example, if one works 30 hours, one would expect a person to produce about 167 units. Also, one can assess an individual's work to see whether the staff member's productivity is above the line (good) or below it (bad).

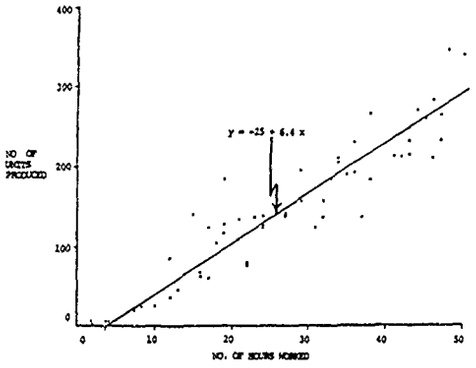


Fig.5 Relationship of number of hours worked and number of units produced

However, there is more information in the data than revealed by the relationship expressed by mere average. For example, by grouping the data by ranges of hours worked as shown in Figure 6, we find that the staff are much more productive, if they work more heavily on the service.

That is, the staff who work less than ten hours on the service over two weeks only produces an average of 2.73 units per hour. If they work 11 to 20 hours they produce an average of 4.66 units per hour, all the way up to 5.81 units per hour for those who work 41 to 50 hours. This relationship (indicator) given by the hypothetical example is not unusual for

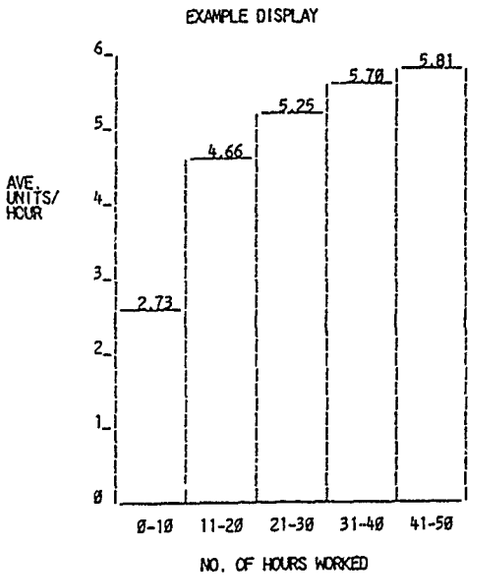


Fig.6

information center services or operational functions. With such knowledge, center managers can improve productivity by centralizing services or batching services. If this can be done for the entire year (1990 in the example), the work can be done in about 29,830 hours instead of 32,600 hours, thus saving $33,240. (i.e., 2,770 hours at $12.00 per hour).

Other factors such as years experience can contribute to productivity as well. In the hypothetical example, this staff attribute is distinguished by the two columns of numbers above, where the first two columns are experienced staff and the second two columns are inexperienced staff. When productivity is calculated by level of experience for the amount of time worked it is found that experienced staff average 6.02 units per hour and inexperienced staff average 4.74 units per hour.

AVERAGE PRODUCTIVITY OF EXPERIENCED AND INEXPERIENCED STAFF

No of Hours Worked	Experience		All
	Experienced	Inexperienced	
0-10	3.04	2.33	2.73
11-10	5.48	3.71	4.66
21-30	5.48	4.48	4.66
31-40	6.41	4.93	5.25
41-50	6.29	5.30	5.81
ALL	6.02	4.74	5.40

Thus, experienced staff would appear to be more productive and this is true at all levels of amount of work. However, an important question is whether it costs experienced staff more per unit since they are paid more. If experienced staff is paid $14.00 per hour and inexperienced staff $10.00 per hour the cost per unit produced for experienced staff is $2.33 per unit ($14.00 per hour divided by 6.02 units per hour) and the cost per unit for inexperienced staff is $2.11 per unit ($10.00 per hour divided by 4.74 units per hour).

Consequently, for this particular example, it would cost slightly less for inexperienced staff to do the work. Overall it would cost about $37,994 less per year to have all the work done by inexperienced staff. The total cost of producing 176,000 units based on the calculated productivity levels by levels of experience and number of hours worked are as follows:

COST TO PRODUCE 176 000 UNITS BY EXPERIENCED AND INEXPERIENCED STAFF

No of Hours Worked	Experience		
	Experienced	Inexperienced	All
0-10	$810 526	$755 365	773 626
11 10	449 635	474 394	453,219
21-30	414,815	392 857	402,266
31 40	384 399	356 996	370 526
41 50	391,733	332 075	363 511
All	$409 30	$371 306	391 144

We have found several relationships to be good indicators for evaluating information centers. These indicators are summarized below.

PERFORMANCE INDICATORS	MEASURES
OPERATIONAL PERFORMANCE INDICATORS (Relate Input to Output)	
Productivity	Output Quantities/Input Costs
Cost Per Output	Input Costs/Output Quantities
Cost By Attribute Levels	Average Input Costs By Levels of Output Attributes
Productivity By Attribute Levels	Productivity By Levels of Output Attributes
EFFECTIVENESS INDICATORS (Relate Output to Use)	
User Satisfaction	Satisfaction Rating Scores/ Number of Ratings
Turnover Rate	Amount of Use/Output Quantities
Amount of Use By Attribute Levels	Average Amount of Use By Levels of Output Attribute
Satisfaction by Attribute Levels	Average Satisfaction By Levels of Output Attribute
Amount of Use By Satisfaction Levels	Average Amount of Use By Levels of Satisfaction
COST EFFECTIVENESS INDICATORS (Relate Input to Use or to Domain)	
Cost Per Use	Input Costs/Amount of Use
Cost Per User	Input Costs/Number of Users
Cost Per Capita	Input Costs/Number in Service Population
Cost By Satisfaction	Average Input Costs By Levels of Levels Satisfaction
IMPACT INDICATORS (Relate Use to Potential Use or to Domain)	
Users as a Proportion of Population	Number of Users/Number in Service Population
Uses Per Capita	Amount of Use/Number in Service Population
Needs Fill Rate	Number of Needs Filled/ Number of Needs Identified
Amount of Library Use By Productivity	Amount of Information Center Use/ User Productivity
Amount of Library Use By Attribute Levels	Amount of Information Center Use/ User Output Attributes

3.4 Methods

A listing and description of measures were presented in Section 3.2. The principal measures include: input costs, output quantities, amount of use, number of users, user satisfaction with services, number of persons in the service population, user needs and proportion needs filled. Each of these measures has associated attributes that can also be measured. Several basic methods can be used for obtaining the measures: internal and external surveys, resource allocation, staff records, other information center records, local authority records, census data, peer review and expert review. Examples of the methods used for each measure are presented below:

MEASURES	METHODS
SERVICE INPUT COSTS	
Amount of resources	Observe payments, record staff logs, etc , cost finding for allocation of resources
SERVICE OUTPUT	
Quantity of output	Staff records center records internal surveys
Quality of output	Observation, internal surveys, peer review, expert review
Timeliness of output	Staff records
Availability	Center records
Accessibility	Staff records, visitor survey, general use survey, specific service survey,population survey
SERVICE EFFECTIVENESS	
Amount of Use	Library records visitor survey, general user survey, specific service survey, population survey
Number of Users	Library records visitor survey general user survey specific user survey, population survey
User Perception of Attributes	Visitor survey, general user survey specific service survey population survey
User Expressed Satisfaction	Visitor survey, general user survey, specific service survey, population survey
User Indicated Importance	Visitor survey, general user survey, specific service survey, population survey
Purpose of Use	Visitor survey, general user survey, specific service survey, population survey
Consequence of Use	Visitor survey, general user survey, specific service survey, population survey
SERVICE DOMAIN	
Number of Persons in	Organization records, telephone directories, Population Survey
Number of Needs	Population Survey, visitor survey, general user survey, specific service survey
Number of Needs Filled	Population Survey, visitor survey, general user survey, specific service survey

Some basic concepts of measures and methods are discussed in Parts 2 and 3. Also detailed discussions on measuring staff costs, measuring the costs of other resources, measuring output quantities and attributes, and measuring service effectiveness and domain values are presented in those Parts.

Part 2

Evaluation of Information Center Operational Performance

Chapter 4

Concepts for Evaluating Operational Performance

4.1 Background

This chapter provides concepts for evaluating operational performance. A description is also given of a system of measures that can be used by information center management and those concerned with the overall budget and operations of the center. In particular, evaluation and the system of measures are designed to assist in the following functions:

- *Monitoring* information center operations for control of resources, prevention of undesired problems, and diagnosis when trouble occurs, in order to treat the difficulty.
- *Financial management,* including annual budgeting, ad hoc modifications to the budget, and adherence to the budget.
- *Personnel management,* including (1) determination of information center staffing patterns and (2) periodic review of information center units and individual staff members.
- *Systems and equipment management,* including determination of system needs and review of adherence of performance to contract specifications
- *Facilities management,* including adjustments to growth.
- *Planning,* including setting measurable objectives and determining strategies for change.
- *Marketing and public relations* for achieving objectives and following strategies.

We refer back to the conceptual framework for evaluation in Chapter 2.

Evaluation is done from three perspectives: information center operations, center users (principally professionals) and their work, and the users' organization. The reason that we suggest that one focus on more than the information center operations is that the center services are likely to have a significant effect on the work of professionals. Furthermore, the better these services are provided the greater the benficial effect on users. We also have found it useful to think of the information center operations in terms of functions, services, activities and resources: each of which has input costs and output quantities, quality, timeliness, and so on. User's work processes also have inputs and outputs which are affected by the center services. A system of measures can be derived to relate the center outputs to their effect on users' work, at least through indicators. The framework in Figure 4 Chapter 2 shows how this can be done.

In the figure, the information center is shown to have functions; each of which have inputs and outputs. The inputs involve the application of resources such as staff, equipment, facilities, etc., which are necessary to perform the functions. We have identified a number of general functions and six categories of resources which are discussed in detail in this Manual. The resource inputs are the cost of resources (e.g., salaries and wages of staff, allocated equipment costs, rent or space costs, etc.) and the resource outputs are the amount of staff and their time, equipment amount and time, etc. that are available to address the service needs of the organization.

The inputs for services and functions, then, are the total application of resources or total amount of resources necessary to perform the functions (e.g., $200,00 or the sum of individual resources such as two staff, one terminal, 400 square feet of facilities, etc). Outputs for services and functions are measured in such terms as quantities produced and output attributes such as quality, timeliness, availability and accessibility.

Performance of staff (or other resources) can be measured in terms of their output (e.g., 2,000 online searches performed, average rating of relevance of search output of 4.21, average response time of 2.4 days, 3,000 hours of staff available to perform online searches, etc.). We consider such simple measures to be output attributes. Performance can also be measured by relating outputs to inputs. Productivity (which is output quantities divided by input costs or amount of staff time) is the most common such measure. For example, productivity might be 0.01 searches per dollar or 0 67 searches per labor hour. The inverse of productivity is easier to interpret: $100 per search or 1.5 labor hours per search. It is also possible to relate input costs or labor time to level of quality. For example, if rating of quality is one to five, (where one is the lowest quality and five is the highest quality), one could compare average cost necessary to achieve five levels of quality as, for example:

Level of Quality	Avg. Cost	Avg. Hours of Labor	Other Costs
One	$ 45	0 9	$18
Two	$ 50	1.0	$20
Three	$ 60	1.2	$25
Four	$ 80	1 5	$35
Five	$110	2 0	$50

Thus, one can establish how much it costs to achieve various levels of quality (and timeliness, availability and accessibility, for that matter). The input costs can vary by such factors as type of search (e.g., quick look-up vs. in-depth) and attributes of resources (e.g., level of searcher knowledge, skills, attitudes, terminal baud rate, database used, etc.) which affect input costs and effort of searchers.

Users' work processes also have input resources and costs associated with them. One of the most important resources used by professionals is information, which is often obtained through or by the information center. The cost, amount, quality, and timeliness of the information as a user resource

is partially determined by the output performance of the center. We have shown in our studies that the extent to which the center services are used depends on such factors as user satisfaction with service performance, awareness of services, availability of services (e.g., hours of opening), accessibility of services (e.g., distance to the center), and perceived relationship of price (i.e., cost to use) and value of services. We consider effectiveness of the information center to be measured in such terms.

Performance is viewed from the perspective of the information center. Center management can control performance directly by decisions concerning operations and resources and how they are allocated. Effectiveness is viewed from the perspective of users. However, center management can only indirectly affect the effectiveness (i.e., the consequences) of center services because so many factors other than center performance contribute to effectiveness (i.e. determine extent to which services are used). In addition to output performance, other factors which are related to effectiveness of center services include extent and type of information needs, availability and cost of alternative sources of information, knowledge and attitudes of users concerning center services in general, weather, and so on. Nevertheless, measures of effectiveness are important to observe and linkages of measures of input or output of center functions to effectiveness measures are useful indicators and decision-making tools.

Effectiveness of information center services can be measured in terms of extent of use, amount of repeated use, user satisfaction with quality, timeliness, availability and accessibility of services, proportion of service needs that are met (i.e., so-called fill rates), and so on. In addition, one can derive a whole range of other measures that provide indicators of the performance and effectiveness of center operations and services

Derived measures would include:

- Cost per capita (i.e., population, potential users, actual users, etc.),
- Quantities or use per capita,
- Average cost per levels of satisfaction with quality, timeliness, etc.
- Average use per levels of satisfaction,
- Proportion of target audience reached, and so on.

Such measures can be monitored over time, e.g., annually, to provide indicators of changes in center operations or users served.

We have shown in a number of evaluations that information center services affect user performance and we believe that user outputs, in turn, affect the entire organization served and even higher order effects such as GNP and quality of life. Higher order effects may be incorporated in the mission of the organization served by an information center, and the mission of the center is to help the organization achieve its mission, goals and objectives. The goals of the center can be thought of in terms of the services provided in light of user information needs and requirements expressed in terms of performance. In this way, one can link the center's objectives to goals, and goals to mission, through the linkages of performance measures to effectiveness measures to higher order effects (even though such higher effects cannot be measured).

A word needs to be said about output quantities since, for services at least, these quantities can be the same as amount of use. One can think of output quantities as being production-driven or demand-driven. Production-driven quantities would include such operational outputs as items cataloged, items acquired, etc. Demand-driven outputs are those determined by users' needs, such as online searches, items circulated, amount of reshelving, etc. In some ways, the production-driven outputs are easier to manage and productivity based on them is more easily observed. On the other hand, if there is sufficient demand, the demand-driven output can be relatively easily managed as well Finally, extent of use of information center services or materials can actually be less than output quantities (if one orders but does not read a book, for example) or more than output quantities (if one passes on a book to colleagues, for example).

In Section 4.2 of this chapter, a list of possible measures of input, output (performance), operational performance, effectiveness and other derived measures are given for principal resources and services. Levels of input, output and performance of information center operations and services are dependent on a number of factors. Some factors are controllable (at least largely so) by management (e.g., competencies of staff hired, attributes of systems and equipment purchased, etc.), while other factors management can only indirectly control, that is, respond to, (e.g., type of users served, their collection requirements, etc.).

There are several types of resource components that management can utilize to perform the center functions and provide its services, including.

- The collection
- Staff
- Facilities (e.g., space, shelving, seating, etc.)
- Systems and equipment (e.g., computers, terminals, etc.)
- External services (e.g.,contractors,vendors, etc.)

There are attributes associated with each of these resource components that affect both input costs and output performance Examples of such attributes are listed below by type of resource component·

- Collection
  - Type of material (books, periodicals, government documents, microform, A-V, etc.)
  - Type of publisher (foreign, domestic, commercial, professional society, etc.)
  - Collection (main, reference, etc)
  - Subject (medical, science, statistics, etc.)
  - Category (e.g , language)
  - Age
  - Other
- Staff
  - Level (e.g., professional, paraprofessional, clerical, support; GS-rating)
  - Full-time, part-time
  - FTE, head count, positions (budgeted)
  - Levels of competencies (i.e., knowledge, skills, and attitudes)
  - Education
  - Experience
- Facilities
  - Total space, net assignable space
  - Study facilities

  - Shelving (open, closed, remote)
  - Handicapped access
  - Meeting rooms, etc.
  - Utilities (e.g., heat, light, etc.)
  - Features (e.g., architectural design, layout, no. of floors, no. of restrooms, etc.)

- Equipment
  - Computers
  - Staff use, patron use
  - Systems/subsystems (e.g., acquisitions, serials control, etc.)
  - Features (e.g., amount of memory, touch terminals, etc.)
  - Photocopiers
  - Staff, patron use (free, coin-operated)
  - Features (e.g., two-sided, color, collation, etc.)
  - Audiovisual (AV)
  - Microform readers/printers

- External Services
  - Contractor
  - Vendor services
  - Consultant services
  - Cooperative arrangements

These are examples of attributes that are likely to affect input costs and output performance. Thus, in some instances at least, it will be important to observe input, output and performance by the classes of attributes. For example, copy and enhanced cataloging costs, quantities, quality and productivity should be determined by professional and paraprofessional staff. Cost, quantities and average cost of the collection might be observed by foreign vs. domestic publishers, commercial vs. society publishers, type of materials, or subject.

There are three levels or degrees of observation of such attributes.

- continually observe, present and analyze data by attribute classes,
- continually observe, but present data by attribute classes only occasionally or for diagnostic purposes, or
- do not observe, but have a means of collecting data quickly if needed for diagnostic or other special purposes.

The methods of observing such data are discussed in detail later.

Finally, some of the other derived indicators are computed as per capita averages. The per capita computations could involve several types of populations such as:

Population (per capita computations)
- Entire organization staff (i.e., all employees)
- Professionals in the organization or organizations served
- All users of the information center
- Persons registered (if a library)
- Active users (e.g., those who have used library at least once within past year)
- Visitors to the center (e.g., gate counts)
- Users of a specific service

Thus, one could estimate average cost per capita as average cost per center staff member, per professional, per user, etc. Each such average has some specific meaning.

Output

Output is measured in terms of quantities produced and attributes such as quality, timeliness, etc. There are a number of ways in which work output can be measured, although many activities simply do not lend themselves to specific output quantities (or quality or timeliness for that matter). Quality can be observed by supervisors (or someone else qualified to check quality) by inspecting random output of someone's work. Timeliness can be observed by 100 percent observation of events or with random spot checks. These and other methods of observing quality and timeliness are discussed in detail in Chapter 6.

Not every activity has a clear quantity of output, although many do. Even fewer have quality, timeliness, etc. measures. Table 4.1 lists the 19 basic functions and 60 activities with suggested output measures, where they seem to apply.

Output measures of quantities can be obtained in a number of ways, one of which is by individual staff members. For example, a weekly output log can accompany the weekly time log for some activities. A suggested weekly output log is given later in Section 5.2. On the log are output quality measures and spaces to indicate amounts for each day of the week. Supervisors will have to determine which quantities to collect in this manner and then record the appropriate output quantity measures on the form. The dates of data collection and signatures for both employees and supervisors should be obtained.

4.2 Information Center Performance and Effectiveness Indicators

In this section we discuss measures of input and output, and indicators of operational and service performance, effectiveness and other derived indicators. The measures and indicators are presented initially for resource components (collection, staff, systems and equipment, and facilities) and then for principal functions and services. Examples of measures and indicators are presented along with some suggestions as to the meaning of them. Below, we discuss some important cost concepts because costs require certain rules concerning partitioning, depreciation and allocation that are important to apply Then resource indicators are discussed; followed by examples of indicators of operational performance, effectiveness, and services.

In the previous sections we briefly discussed input costs In this section we discuss cost concepts in much more detail. Service input costs are defined as the application of resources to provide information center services. Examples of resources include:

- financial resources,
- collection,
- staff,
- facilities,
- equipment and systems, and
- all other resources (e.g., furniture, supplies, etc.)

TABLE 4.1
OUTPUT MEASURES

	Quantities	Quality	Timeliness	Availability	Accessibility
Collection Development & Management					
1. Collection development	1) titles reviewed 2) titles acquired	NA scope, comprehensiveness	NA NA	NA NA	NA NA
2. Collection weeding	titles withdrawn	requests after withdrawal	NA	NA	NA
3 Physical withdrawal and related housekeeping	items withdrawn	NA	NA	NA	NA
Acquisitions					
4 Ordering	titles/items/subscriptions ordered	claims per order	order to receipt	item-days unavail	NA
5 Processing materials received	items received	NA	throughput time	item-days unavail	NA
6 Claiming	claims	NA	adherence to schedule	item-days unavail	NA
7 Cancellations	titles cancelled	NA	NA	NA	NA
8 IPL activities	unknown	unknown	unknown	unknown	unknown
Materials Receiving and Mail Processing					
9 Materials/mail processing	1) pkgs. processed 2) other items processed	NA NA	throughput time throughput time	item-days unavail item-days unavail	NA NA
Cataloging					
10 Copy and enhanced cataloging	titles copy catalogued/ recataloged & enhanced	% that conform to stds	throughput time	item-days unavail	NA
11 Original cataloging	titles orig. cataloged	% that conform to stds	throughput time	item-days unavail	NA
12 Journal analysis (orig. and copy)	journal titles analyzed	% that conform to stds	throughput time	item-days unavail	NA
13 Journal cataloging (orig. and copy)	journal titles cataloged	% that conform to stds	throughput time	item-days unavail	NA
14 Added volume and copy	volumes and copies added	% that conform to stds	throughput time	item-days unavail	NA
Catalog Maintenance				NA	NA
15 Catalog additions activities (cards)	titles cataloged (added)	accuracy of filing/input	throughput time	item-days unavail.	NA
16 Catalog withdrawal activities (cards)	titles withdrawn	NA	NA	NA	NA
Physical Processing					
17 Spine labelling, barcode labelling/linking	1) items labelled 2) bound vols. returned	accuracy of labelling NA	throughput time throughput time	item-days unavail. item-days unavail.	NA NA
18. Other physical processing	items phys. processed	quality of processing	throughput time	item-days unavail	NA
19. Monograph binding and repair	items repaired	quality of repair	throughput time	item-days unavail	NA
20 Acquisitions list	lists	NA	throughput time	NA	NA
Periodicals Binding					
21. Set up of binding records	new journal titles (set-up)	accuracy of records	throughput time	NA	NA
22. Preparing materials to be bound	issued to be bound	NA	throughput time	article-days unavail.	NA
23 Processing returned bound volumes	returned bound volumes	quality of binding	throughput time	article-days unavail.	NA
Invoice Processing					
24. Invoice processing	invoices processed	accuracy	throughput time	NA	NA
Reference and Readers Advisory					
25 Directional	directional requests	accuracy	NA	hours of service	waiting time
26 Reference	reference requests	relevance of response	1) speed of response 2) response from negotiated time	hours of service	waiting time

TABLE 4.1
(CONTINUED)

	Quantities	Quality	Timeliness	Availability	Accessibility
Online Bibliographic Searching					
27. Quick look-up	quick look-ups	accuracy of look-up	1) speed of response 2) response from negotiated time	hours of service	waiting time
28 In-depth	in-depth searches	1) relevance of response 2) no. of items retrieved negotiated time	1) speed of response 2) response from	1) hours of service 2) person hours avail.	1) waiting time 2) no. of host dbs avail.
29 SDI	1) profiles prepared 2) outputs distributed	1) relevance of response 2) no of items retrieved NA	NA time from schedule	NA NA	no. of host dbs available NA
Circulation					
30 Circulation	items circulated	NA	speed of response 3) study seats/carrels	1) hours of service 2) loan period	waiting time
Shelving and Reshelving					
31 Shelving and reshelving	items shelved/reshelved	items shelved correctly	throughput time	item-days unavail.	
Interlibrary Borrowing and Lending					
32. No requests fulfilled at library	232 request from library	correct items processed	speed of response	NA	NA
33 Interlibrary borrowing from lib. 1) Staff processing at library 2) Library processing	ILBs from library	correct items processed	speed of response	NA	NA
34 Interlibrary borrowing (and no requests) from other libraries	ILBs from other libs.	correct items processed	speed of response	NA	NA
35 Interlibrary lending	1) requests received 2) ILL items fulfilled	correct items processed correct items processed	speed of response speed of response	NA NA	NA NA
User Instruction					
36 Prepare exhibits	exhibits prepared	quality of exhibits	time from schedule	NA	NA
37. Conduct tours and/or present briefings	tours and/or briefings	quality of tours/briefs	time from schedule	NA	NA
38. Conduct training sessions/ demonstrations	training sessions	quality of sessions	time from schedule	NA	NA
39 Conduct advisory service sessions	sessions	quality of sessions	time from schedule	NA	NA
40. Other user instruction	other instructions	NA	NA	NA	NA
Photocopy Services					
41. Make photocopiers for no requests	no. pages photocopied	NA	throughput time	NA	NA
42. Make other photocopies	pages photocopied	NA	throughput time	NA	NA
43. Check-in users	users checked-in	NA	NA	hours open	waiting time
44 Open and close, work at service maintenance and supply	days open & close	NA	late opening	NA	NA
Translation Services					
45. In-house translation of articles, chapters, etc.	1) items (art., chpt.) translated 2) words translated	accuracy of translation	1) speed of response 2) response from negotiated time	NA	NA
46. In-house archival translation	1) items (art., chpt.) translated 2) words translated	accuracy of translation	time from schedule	NA	NA
47. Processing and monitoring out-of-house translations	1) items (art., chpt.) translated 2) words translated	accuracy of translation	time from schedule	NA	NA
48 Other translation-related activities	NA	NA	NA	NA	

TABLE 4.1
(CONTINUED)

	Quantities	Quality	Timeliness	Availability	Accessibility
Automated Systems Administration					
50. Monitor system performance and usage	NA	NA	NA	NA	NA
51. Vendor related activities	NA	NA	NA	NA	NA
52. Staff related activities	NA	NA	NA	NA	NA
53. Reporting	NA	NA	NA	NA	NA
General and Administration Support					
54. Statistical, and financial data related activities	NA	NA	NA	NA	NA
55. Secretarial/clerical related activities	NA	NA	NA	NA	NA
56 Professional development and training activities	NA	NA	NA	NA	NA
Management and Administration					
57. General administration	NA	NA	NA	NA	NA
58 Planning	NA	NA	NA	NA	NA
59. Financial management	NA	NA	NA	NA	NA
30 Personnel management and staff development	NA	NA	NA	NA	NA

Each service requires the application of one or more of the resources above. For example, online database searching requires reference and support staff, space for staff and service, terminals and peripheral equipment, reference and searching materials, and so on. Generally, these resources are quantified as:

- Financial amounts budgeted for services
- Number of staff or staff hours applied to services
- Amount of space allocated to services
- Number of equipment items and systems used to provide services
- Number of collection items applied or used

It is sometimes only necessary to know the amount of staff time or equipment time used for a service. However, it is often necessary to know the extent to which all resources are applied to a service. Then, the amount of all resources applied to services can be converted into a common unit, which is money or funds. Once the amount of resources applied to services is determined, conversion to measures of money or funds is not too difficult in terms of the following types of measures:

- Wages, salaries or other compensation applied to services
- Amount of space rent or depreciated expenditures applied to services
- Equipment and system lease or depreciated expenditures applied to services
- Price and cost of processing of materials and other stock items applied or used.

It is useful to identify attributes of resources and to carry them through measures of service input and output because decisions may be required concerning the attributes. For example, one may wish to establish productivity (e g , output quantities divided by input costs) for specific levels of staff such as professional, paraprofessionals or support staff. The application of resources needs to be considered in a broader context:

- services, functions or activities for which the resources are applied (e.g., for total operation of the information center, lending collections, reference, etc.)
- a time period (e.g., a year, month, hour, etc.)

The context for measuring resources of course depends on the purpose for which the input measures will be used. The important thing is that the context should be exactly the same for both input costs and output quantities and attributes. Otherwise performance and other indicators cannot be properly interpreted.

A common time period for measuring resources is a year, although other time periods could have meaning for specific problems and decisions as well. Attributes of a resource or service are inherent characteristics of a resource (e.g., education level of staff) or of a service (e.g., subject of reference searches.)

Direct and Indirect Costs

Methods of measuring input cannot and should not attempt to be precise (reasonably accurate but not precise). The reason for this is that measuring the cost of resources in the context of a service often requires allocating resources among several services or functions. For example, a staff member may spend time on reference, interlibrary lending, and administration. Thus, this person (or someone else) must estimate the amount of time spent on each service. Unless the person is observed constantly, it is necessary to rely on memory or even interpretation of what one is doing. However, most purposes for which input costs are measured simply do not require precise measurement and the methods of measuring proposed here and elsewhere are sufficient. The same qualifications hold for application of equipment, facilities and most other resources. Determining the application of all funds in an information center over an annual budget period may require annual audits. When audits are required (as opposed to evaluation) of course the comments above concerning exactness of measures do not apply.

Direct cost is the application of resources which are easily allocated to a service (e.g., line charges for an online search). Thus, direct cost is a cost which is easily identified with a service (e.g., interlibrary lending) or resource (e.g., staff).

Indirect costs are those which are not easily assignable or readily attributable to any one service or function, activity, or resource. Rosenberg[1] (and others) subdivides indirect costs into two categories:

Indirect operating costs. These costs include centrally budgeted items (e.g., utilities, rent, insurance, etc.) that are necessary to the general operation and maintenance of the information center.

Indirect support costs Costs for support services that benefit overall administration of the information center and its services (e.g, administration, accounting, personnel, etc.)

The key to assigning costs into direct or indirect is whether changes in amount of services appreciably affect such costs. Direct costs vary with changes in amounts of service, while indirect costs do not. The indirect costs can be allocated in some equitable way to direct costs such as allocating these costs in proportion to amount of direct costs.

Fixed and Variable Costs

Another concept of cost finding involves fixed costs, semi-fixed costs, variable costs, and incremental costs. Total cost of a service normally consists of the application of a number of resources such as funds, staff, equipment, facilities, etc. Sometimes the resources are applied to the service when the service is requested or used. That is, these costs vary when the service is used and are, therefore, called variable costs. In other instances, resources are purchased or leased for the purpose of applying them to services over a period of time. However, once the expense is incurred, it does not matter how many times the resource is used, the cost is fixed and does not vary. Furthermore, use essentially does not deplete the resource (except when used extensively). An example of use depleting a resource is paper used for photocopies. The cost of paper is a variable cost. Yet the use of the photocopier does not deplete the photocopier as a resource (although use can be denied for a period of time). This is a fixed cost.

There are two kinds of fixed costs: one-time fixed costs and recurring fixed costs. One-time fixed costs represent resources that are purchased outright such as purchase of books and equipment. Recurring fixed costs represent costs that are fixed for short time periods (e.g., a month) but recur over the time periods. Examples of recurring fixed costs are monthly payments for equipment leases and facility rent[2], annual fees paid to vendors or annual subscription prices paid to publishers.

Total cost of information center services is the sum of fixed and variable costs incurred for the services. Obviously total cost increases as the amount of service transactions (or units provided) increases. Figure 7 provides an example of how total cost of a service increases with number of transactions (i.e., output quantities) for that service. If there are no transactions the total cost would be the sum of fixed costs applied to the service such as terminals, facilities, or the collection. If there are transactions there would be an incremental cost associated with resources required to provide each transaction (e.g., staff time, line charges and hit rate charges from the vendor, photocopying of output, etc). The graph shows that incremental costs are equal for each transaction, which is clearly not true for most services. However, for theoretical discussion they can be thought of as being linear. Furthermore, at some point the volume of services is such that a resource is completely used (e.g , a terminal is used to its capacity) and more resources must be purchased to provide any additional services These costs are referred to as semi-fixed or "step costs" and must be added to the variable and fixed costs as shown in the figure

Allocation and Depreciation of Costs

Calculating the total cost of a service would be relatively simple if resources were always dedicated exclusively to specific services. Unfortunately, this is rarely the case except with very large information centers where, for example, staff can be assigned exclusively to do searching, cataloging, or interlibrary loan and so on. Even in large centers computer equipment and systems are used for multi-purposes and facilities are used for most services (except those provided in branches or when remote warehousing is used for storing older materials). Allocation of costs is the process of determining the extent to which resources are applied to specific services. For example, allocation of staff is done by determining how much time staff spend on specific services and other activities. Examples of methods for allocating staff, collection, equipment and other resources are discussed in the methods chapter of this Manual (Chapter 5).

[1] Definition of terms are adopted from *Cost Finding for Public Libraries,* Philip Rosenberg, American Library Assn., 1985.

[2] One could also think of staff salaries as recurring fixed costs, but there are reasons for not doing so, one of which is that personnel can be redeployed if this resource cannot be usefully applied to a service.

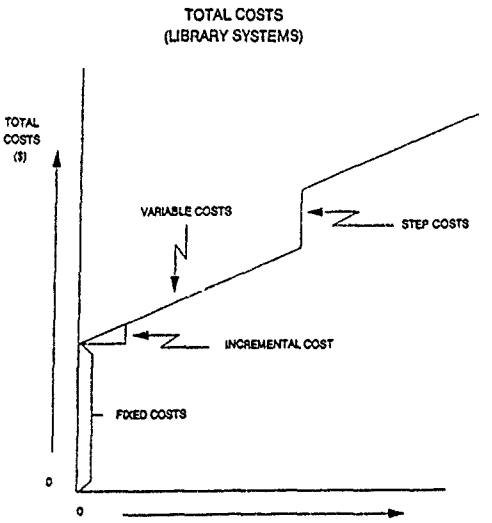


Fig.7 Number of transactions/units

A special kind of allocation is done when resources are expensed rather than expended. For example, if equipment is purchased outright, the amount paid is the expenditure. On the other hand, it may well be advantageous to allocate the cost of a resource over the time period it is likely to be used. This allocation process is called depreciation. The amount allocated is an expense. Depreciation involves spreading expenditures for such resources as computer equipment, facilities and so on.

Usually accountants recommend methods for calculating depreciation amounts over time, or actually perform calculations for information centers. The simplest method of calculating depreciated expenses is to divide expenditures equally among planning years. This can be done using the following steps:

(1) Establish a useful period of life for the resource; for example 7 years for a mainframe computer, 5 years for minicomputers, 3 years for microcomputer, 50 years for buildings, etc.

(2) Estimate a write-off value for the resource at the end of its useful life.

(3) Calculate the equal annual write-off value; the difference divided by the number of years in useful life.

For example, for a minicomputer:

$$\frac{\$12{,}000 - \$1{,}200}{5 \text{ years}} = \$2{,}160 \text{ per year}$$

For many reasons, accountants prefer not to use linear depreciation (i.e., equal amounts over the years). One reason that linear depreciation is not used is that use of the resource is likely to reduce over time. Another reason is that the value of money changes over time. Note that a depreciated cost can, and often is, further allocated among services (in addition to allocation to specific time period).

Average or Unit Costs

Once the fixed and variable cost of resources have been properly allocated, it is possible to calculate total cost over a specified time period associated with a service or activity. Average or unit costs of services can be calculated by dividing total cost by total output quantity. Examples of average cost include cost per book loaned, cost per online search, cost per item used in the information center, cost per interlibrary loan, etc. This derived performance indicator is extremely useful, but rarely calculated by information centers. Such averages are probably the single best indicator of how well a center is performing in terms of costs. The inverse of average cost (i.e., total quantities produced or transactions divided by total cost) is productivity.

An example is given below for calculating average cost. Assume that the fixed cost of a service, say online searching, is $10,000 (i.e., including a terminal, space, photocopier, furniture, reference materials, etc.) and the incremental cost is $100 (i.e., line charges, hit rates, photocopy, staff, etc.). If there are two searches the average cost is $5,100 ($10,000 + 2 × $100 divided by 2), three searches $3,433 and so on. As the number of searches increases, say to 100 searches, the average cost drops to $200 ($10,000 + 100 × $100 divided by 100), a number much nearer $100, the incremental cost. At 1,000 searches the average cost is $110. One can continue to increase the number of searches and the average cost will continue to come closer to $100 but never quite reach it. Thus, the incremental variable cost is an asymptote (i.e., an amount closely approached but never reached).

At some amount of transactions the average cost approaches an asymptote which, in fact, is the incremental variable cost as shown in Figure 8. This point at which average cost approaches the incremental cost can be thought of as a "critical mass". From an information center funder's perspective, it is desirable for services to be provided at or near the critical mass because it is at this point that the difference between costs of services and value received is at its optimum. Information centers and their branches can achieve a critical mass for such activities as acquisitions and physical processing by centralizing the functions to increase number of transactions or units processed.

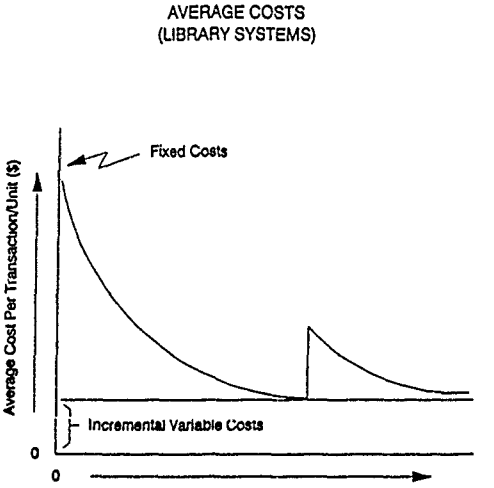


Fig.8 Number of transactions/units

The figure shows that a "step cost" will affect average cost, but not at the level of the entire step cost because the amount of the step cost is averaged over a large number. For example, assume, that a new terminal at $2,000 is required after 2,000 searches (i.e., 2,001 searches). The average cost at 2,001 searches then is $106 ($12,000 + 2,001 × $100 all divided by 2,001), a value not much higher than $105 the amount at 2,000 searches without the new terminal. Obviously, an information center would not purchase a terminal in order to conduct one search, but rather search off-hours, etc. with the initial terminal. However, in theory and not too far off in practice the average cost is as shown in the figure.

Economies of Scale

Spreading of large fixed costs over a large number of transactions or units results in reduced average cost. This phenomenon is referred to as achieving economies of scale. Economies of scale can be achieved in other ways as well. For example, large information center operations can normally perform some production-like activities less expensively than small ones. An example is processing interlibrary loan requests, indexing or cataloging. By batching these activities, they can normally be done more productively than if they are done in an on-again, off-again manner. Economies of scale can also be achieved in larger operations by having staff with specialized competencies (i.e., knowledge and skills developed through education, training and experience). The extreme example would be small information center run by a professional staff member who is required to catalog, search, open the mail and reshelve materials. Also, large operations can often negotiate volume discounts for purchasing services, supplies, materials, equipment, etc.

There are diseconomies of scale as well. Typically, in information centers and other organizations it often costs more on the average to administer operations as the size of the organization increases. That is, the proportion of total costs accounted for by administration tends to increase as the total costs increase. There may be many reasons, if and when this happens, but probably the principal reason is that communication and maintaining control is harder in larger organizations.

There is a question of whether one should use average cost (i.e., total cost divided by total transactions) or productivity (i.e., total transactions divided by total cost). Each performance indicator has a useful meaning. For example, funders may ask what they are getting for the dollar expended. Productivity is an indicator of what they receive. The equation for productivity is as follows:

Productivity = Total transactions divided by total cost.

This equation can be reversed as follows:

Total transactions = Total cost times productivity.

Thus, if productivity is increased funders will get more transactions for their investment or if they invest more or less they can forecast the effect on the output. Economies of scale play a role, however, because of fixed costs. Assume that there are 1,000 searches and the fixed and variable costs are as given above. A funder might ask what would happen, if they cut the budget in half, from the current amount of $110,000 to $55,000. The number of searches possible would be cut from 1,000 to 450 (i.e., $55,000—$10,000 all divided by $100). Thus, the number of searches would be reduced by more than one-half (450 vs. 500). If management focussed on increasing productivity of searchers say, by 25 percent one can establish what effect that would have on cost. If the $100 variable cost, assumes that the components of this cost is $45 vendor changes, $2 photocopying, $3 for support staff and $50 for professional time. Then the total cost for 1,000 searches would decrease from $10,000 to $97,500 and average cost would decrease from $110 to $97.50. Thus, savings would be $12,500. If the cost to achieve these savings is higher than that amount, the decision might not be to train, hire or whatever necessary to accomplish improved productivity unless quality, timeliness, etc. is affected or that the productivity improvement affects vendor costs as well.

There are basically four ways in which the productivity rates should be utilized:

(1) In some instances, productivity should be observed and reviewed on an ongoing basis. This is done for activities which involve regular production-like work such as cataloging, some physical processing, photocopying and so on. The review can serve as a means of monitoring individual staff, certain activities and units.

(2) Sometimes it is too difficult to monitor productivity on an ongoing basis for individuals because output is difficult to attribute to a particular staff member (e.g., circulation) or the staff members are performing a variety of activities at ill-definable times. In these instances, the entire activity can be monitored, but individuals are more difficult. Here, it is still necessary to observe over time. One can then reverse the calculations and determine if sufficient output is achieved from collective input.

(3) There are many activities in which there is no measurable output such as in management and administrative activities. In these instances, one can still establish, by the formulas given, whether or not the amount of time devoted to the activities adheres to norms based on staffing patterns in the center.

(4) Finally, as mentioned previously, data can be used in the aggregate to monitor the staffing patterns and to help budget and plan for the future based on forecast levels of services.

These uses of the productivity measures should be kept in mind when reviewing productivity values.

Other operational performance would include the inverse of productivity (i.e., hours per item produced or dollars per item produced). In addition, average cost per level of quality (timeliness, availability, or accessibility) can be computed from input and output measures when appropriate. These operational performance measures provide an indication of what it costs to achieve different levels of quality. Since average cost is the inverse of productivity one can also derive productivity at the different levels of quality. All of the operational performance measures are derived from input and output measures and, therefore, do not require data collection themselves.

Across the board, the data can be applied in several ways. For example, for upcoming budgeting one can forecast amount of activity (e.g., no. of ILLs, in-depth online searches, etc.) that should be expected in the upcoming year.

By multiplying the inverse times the number of forecast quantities of output, one can estimate the number of staff required. For example, if there were 6,983 in-depth online searches in the base year and that number is expected to grow to 9,000, the staff requirements would be 8,257 hours or about 4.6 FTE staff (1 divided by 1.09 searches per hour x 9,000 searches). Such computations can be made to establish the entire information center staff size and staffing patterns can be determined by taking the 1986 norms and determining for each of the 17 functions by the proportion that are professional, library technician and clerical. These proportions then can be multiplied by the sum of staff time for all activities in the functional areas.

Sometimes average cost is a better indicator to utilize than productivity. First, productivity is sometimes more difficult to interpret. For example, if average cost of online searching is $100 per search, the corresponding productivity indicator would be 0.01 searches per dollar. Second, average cost, when broken down into components, can be used for budgeting purposes. For example, if an information center has trend data on amount of online searching done, items loaned, etc., it is possible to use a forecast of amount of searching to forecast resource requirements.

Resource Indicators

One can view input and output resources in light of a decision to acquire a resource component (e.g., hire a staff member, purchase a system, etc.). Thus, input would then be the cost of the resource component (i.e., salary and fringe benefits for staff, contract amount for equipment, etc.) and output would be amount of resource(s) purchase (i.e., total staff hours, number of terminals, etc.) and expected (or achieved) quality, timeliness, availability, accessibility, and so on. Examples of input and output are given in Table 4.2, for collection, staff, systems and equipment, and facilities.

TABLE 4.2
RESOURCE PERFORMANCE AND EFFECTIVENESS INDICATORS

RESOURCE	INPUT	OUTPUT	OPERATIONAL PERFORMANCE	EFFECTIVENESS	OTHER DERIVED INDICATORS
COLLECTION	Cost ($) Resources Attributes Additions, withdrawals	Qty. (Titles, items) Attributes Additions, withdrawals	Cost/Qty.	Extent of Use: Circulation In-house (patron, staff) ILL	Cost per capita Avg cost/level of satisfaction
		Quality (Scope - what covered, comprehensiveness - how well covered)	Qty./Cost Avg cost/level of qual.	Purpose of Use User satisfaction with quality, availability, accessibility	Cost/extent of use Extent of use/capita Turnover rates
		Availability (hours available, stock unavailable - in process, on loan, missing, etc)	Avg. cost/level of availability	Fill rates (e.g., title, authors, subject, browsing, etc)	Avg. use/level of satisfaction Qty./capita
		Accessibility (open vs. closed stacks, remote, etc.)	Avg cost/level of accessibility	Multiple use Multiple users	ILB/quantities ILB/extent of use Proportion of collection on loan
STAFF	Cost ($) Resources Attributes Fringe benefits	Qty. (head count, FTEs, hours of work) Attributes	Cost/Qty. Qty./Cost	Output of work	Cost/unit of output
		Quality (productivity, accuracy of work, etc.)	Avg cost/level of qual.	Management or user satisfaction with quality	Cost/capita
		Availability (actual hours worked)	Avg cost/level of availability		Avg. cost/level of satisfaction
EQUIPMENT & SYSTEMS	Cost ($) Resources Attributes	Qty. (Amt. of equipment, no. of hours) Attributes	Cost/Qty Qty./Cost	No. of uses No. of users	Cost/capita Cost/use
		Quality (reliability, screen readability, etc)	Avg cost/level of qual.	Purpose of use	Uses/capita
		Timeliness (response time, baud rate, etc)	Avg cost/level of timeliness	User satisfaction with features, quality, timeliness, accessibility	Hours of use/capita
		Accessibility (no. of hours available)	Avg cost/level of accessibility		Proportion of total/available hours actually used Avg cost/level of satisfaction
FACILITIES	Cost ($) Resources Attributes	Qty. (Total space in sq ft., usable space) Attributes	Cost/Qty Qty./Cost	No. of visits No. of visitors	Cost/visit Cost/capita
		Quality (ease of use, pleasantness of surroundings)	Avg cost/level of qual.	Hours of use	Cost/hour of use Visits/capita
		Availability (hours open)	Avg. cost/level of availability	Purpose of use	Visitors/capita Hours of use/capita
		Accessibility (avg distance in time or miles to constituents served, amt. of parking, entrance for disabled, etc.)	Avg. cost/level of accessibility	User satisfaction with quality, availability, accessibility	Avg. cost/level of satisfaction

For resources, input is always measured by cost in dollars. For example, cost of the collection includes purchase, price, input processing, cataloging, shelving, storage and withdrawal. Thus, there are a number of resources involved in the cost of the collection and the cost will vary by collection attributes over time. The price paid each year for the collection is an expenditure; however, we feel that costs should reflect an allocation of this expenditure over time. As an approximation, use by age can be used. Input costs of systems and equipment, facilities and staff should include allocation of expenditures and all other costs associated with these resources. In addition to attributes of the collection given in the previous section, another important attribute is collection additions and withdrawals, since they affect input cost. Type of fringe benefits is an additional attribute for input cost of staff.

Output of resources reflect quantities such as titles or items in the collection; a head count, FTEs, hours of work for staff; systems and amount of equipment; and square feet or net assignable square feet for facilities. Just as input cost can be classified by attributes, so can output. However, it only makes sense to classify both by the same attributes. Other outputs for collection include the scope of the collection in terms of what is covered and comprehensiveness of the collection in terms of how well it is covered. Availability of the collection is observed in terms of (1) the hours (say, per week) the collection is open and (2) unavailability due to use in the library, on loan or missing (misshelved, stolen). Accessibility is determined by extent of open stacks, closed stacks, or remote storage. Output of staff is determined by quality of work and availability of actual hours worked (i.e., taking away vacation, sick leave, holidays, personal time taken off). With systems and equipment, other outputs resulting from input costs include quality, response times (timeliness), and number of hours available. Finally, other facility outputs include quality of the facilities, hours open (available) and distance to users (availability).

Indicators of Operational Performance

Indicators of operational performance involve relationships between input costs and output performance. For example, for indicators of the collection is operational performance might be $2.00 per title for open storage and $1.00 per title for remote storage. Other examples might be $20 per FTE for staff, $20 per net usable square foot of space, and so on. Average cost per level of quality, availability and accessibility are indicators of what it costs to achieve these levels. Thus, if actions are anticipated or taken to change the levels, management will roughly know effects on costs.

Indicators of Effectiveness

Indicators of effectiveness show the consequences of the resources; input cost and output attributes. Such indicators are generally measured in terms of extent of use; user satisfaction with quality, timeliness, availability and accessibility; and some rates such as collection fill rates (i.e., proportion of needs satisfied by the collection). Extent of use of the collection would include circulation, in-house reading and use, and interlibrary lending. For staff this would be the output of work for various functions, which are discussed below; systems and equipment, the number of uses for each system or type of equipment; and visits as a measure for the center. Other indicators of effectiveness include number of users and proportion of population who are users. One does not expect everyone in an organization to use the collection or visit the information center but if only 10 percent of the professionals do, or if the proportion is decreasing over time, there is an indication of potential problems. Repeated use by users is also an indicator of effectiveness. Poor service (in quality or timeliness) can lead to use of alternative services; thus, repeated use is an indicator that users are sufficiently satisfied to continue using the collection, systems or equipment and facilities.

Purpose of use and user satisfaction can be observed through user response forms (for specific incidences of use) or from general survey questionnaires. Purpose of use refers to the purpose for which information is used, such as patient diagnosis, clinical research, management, professional development, and so on. Purpose of use is an indicator of effectiveness and degree to which the information center services contribute to the parent organization's mission. User satisfaction with services or service output performance can be measured by rating scales (say, 1 to 5). For example, one can rate satisfaction with relevance of online search results. It is useful to obtain such satisfaction ratings with specific instances of use.

Other Derived Indicators

It is possible to derive many indicators from relationships between input and effectiveness, output and effectiveness, and operational performance and effectiveness. Generally, the following derived indicators are found to be useful:

- Cost per capita (total population, user population, users)
- Cost per use
- Extent of use per capita
- Output quantity per capita
- Hours of use per capita
- Average cost per level of satisfaction — in order to determine what it costs to achieve various levels of user satisfaction
- Average use per level of satisfaction — to establish the importance of user satisfaction
- Purpose of use per capita

Other extremely important indicators are (1) the total demand for services (i.e., how much services are used from the center *and* other sources) and (2) the costs of using alternative sources It is shown in Chapter 13 that alternative sources often cost users much more in their time and in dollars than in using the information center. The difference in cost is a measure of the value of the center to users.

Services and Function Indicators

Some examples of measures of input and output and indicators or operational performance and effectiveness are given for services and functions in Table 4.3. Services and functions are different than resources in several ways. First of all, input can be measured both in terms of (1) the total cost of all the resources necessary to perform a function or provide a service and (2) the amounts of resources expended. For example, input to collection development can be dollars expended or number of labor hours expended. Labor hours, of course, is the output of the resource. Labor hours (and other amounts of resources) are useful for monitoring productivity of individuals or an information center unit. Yet, ultimately, management may want all resources to be expressed in the common unit of dollars. The inputs of the services and products are expressed in costs($) and amounts of resources.

Operational performance may also be expressed in such terms as hours per item produced. However, we have not carried the amounts of resources to the other derived indicators. It is noted that amounts of resources are also affected by attributes and other factors. Second, services and functions are more likely to have additional attributes that affect input and output. There are also more extensive indicators of effectiveness and other derived indicators.

TABLE 4.3
LIBRARY PERFORMANCE AND EFFECTIVENESS INDICATORS

SERVICE/ FUNCTION	INPUT	OUTPUT	OPERATIONAL PERFORMANCE	EFFECTIVENESS	OTHER DERIVED INDICATORS
COLLECTION DEVELOPMENT AND MANAGEMENT	Cost ($) Resources Attributes Additions, withdrawals Amount of Resources Attributes Addition, withdrawals	Qty. (titles, items) Attributes Additions, withdrawals Quality Scope Comprehensiveness	Cost/Qty. Amt. of Resources/Qty. Qty./Cost Qty./Amt. of Resources Avg Cost/Level of qual.	See Collection	See Collection
ACQUISITIONS	Cost ($) Resources Attributes On-Demand Orders, Other Direct Orders, Standing Orders, On-Approvals, Gifts Cancellations, Claims Receipts Amt. of Resources Attributes	Qty. (Orders,Titles, Items) Attributes On-Demand Orders, Other Direct Orders, Standing Orders, Qty./Amt. of Resources Cancellations, Claims Receipts Timeliness (Time between order and receipt) Qual. (Claims per order)	Cost/Qty. Amt. of Resources/Qty. Qty./Cost Avg Cost/Level of Timeliness Avg Cost/Level of Qual	User satisfaction w/ timeliness of on-demand orders	Qty./capita Cost/capita
CATALOGING	Cost ($) Resources Attributes Copy, Enhanced, Original Amt. of Resources Attributes	Qty. (Titles, Items) Attributes Copy, Enhanced, Original Qual. (% that conform to standards) Timeliness (cataloging throughput (time)	Cost/Qty. Amt. of Resources/Qty. Qty./Cost Qty./Amt. of Resources Avg Cost/Level of Qual	Extent of use of catalog Catalog fill rate User satisfaction with ability of catalog to identify items by author, title, subject, etc Ease of use	Use of catalog/capita Cost/level of fill rate Satisfaction/level of fill rate Cost/level of satisfaction
CIRCULATION & IN-LIBRARY USE	Cost ($) Resources Attributes Class of User Circulated, reserved renewed, in-library use Amt. of Resources Attributes	Qty. (Loans, Items) Attributes Class of User Reserved, renewed, in-library use Timeliness (Avg queing time) Availability (hours of service, loan period, study seats)	Cost/Qty Amt. of Resources/Qty Qty./Cost Qty./Amt. of Resources Avg Cost/Availability	Extent of Use User satisfaction with timeliness, availability	Cost/capita Avg. cost/level of satisfaction Qty./capita Avg. use/level of satisfaction Use/availability
SHELVING/ RESHELVING	Cost ($) Resources Attributes Amt. of Resources Attributes	Qty (Items) Attributes Copy, enhanced, original Qual. (% shelved correctly) Timeliness (Avg. time off shelf)	Cost/Qty. Amt. of Resources/Qty. Qty./Cost Qty./Amt. of Resources Avg Cost/Level of Qual. Avg Cost/Level of Timeliness	Fill rate failure resulting from (1) items awaiting reshelving and (2) inaccurate reshelving	
INTERLIBRARY BORROWING & LENDING	Cost($) Resources Attributes Class of User Requests sent, sent/ fulfilled, received, received/fulfilled ILL/LBs by photocopies, originals Amt. of Resources Attributes	Qty. (Requests, Items) Attributes Class of User Requests sent, sent/ fulfilled, received, received/fulfilled Timeliness (time between requesting items from other libraries and receipt; time between receiving requests for items from other libraries and sending them out or referral; time between sending out items to other libraries and receiving them back)	Cost/Qty. Amt. of Resources/Qty Qty./Cost Qty./Amt. of Resources	Extent of Use User satisfaction with borrowing and lending Request fill rate loans to other libraries Request fill rate loans from other libraries Proportion of items loaned that are returned soiled or damaged	Cost/capita Avg. cost/level of satisfaction Qty./capita Avg. use/level of satisfaction Avg. use/fill rate

TABLE 4.3 (CONTINUED)
LIBRARY PERFORMANCE AND EFFECTIVENESS INDICATORS

SERVICE/ FUNCTION	INPUT	OUTPUT	OPERATIONAL PERFORMANCE	EFFECTIVENESS	OTHER DERIVED INDICATORS
REFERENCE & INFORMATION SERVICES	Cost ($) Resources Attributes Class of User Directional, in-depth Telephone, written, in-person Amt. of Resources Attributes Class of User Directional, in-depth Telephone, written, in-person	Qty. (Enquiries) Attributes Class of User Received, completed, referred Qual. (Accuracy, comprehensiveness of response, relevance of response) Attributes Class of User Received, completed, referred Timeliness (Time between enquiry, receipt and response to user; negotiated time and response) Attributes Class of User Received, completed, referred Availability (Hours of service; person hours of availability) Accessibility (Avg. wait time)	Cost/Qty Amt. of Resources/Qty. Qty./Cost Qty./Amt. of Resources Avg Cost/Level of Qual. Avg Cost/Level of Timeliness Avg Cost/Level of Availability Avg Cost/Level of Accessibility Qty./Availability	Extent of Use Attributes Class of User User Satisfaction: Quality, Timeliness Availability Accessibility Reference fill rates Repeated use	Cost/capita Avg cost/level of satisfaction Qty./capita Avg use/level of satisfaction Avg use/fill rates Use/availability
TOURS/ BRIEFINGS/ TRAINING SESSIONS	Cost ($) Resources Attributes Class of User Type of Activity Amt. of Resources Attributes Class of User Type of Activity	Qty. (No. of events held, hours of events) Attributes Class of User Type of Event Qual. of events Timeliness (frequency of events)	Cost/Qty. Amt. of Resources/Qty Qty./Cost Qty./Amt. of Resources Class of User Avg cost/level of qual. Avg cost/level of timeliness	Attendance User satisfaction with quality, timeliness Repeated use	Attendees/qty Cost/capita Avg cost/level of satisfaction Attendance/capita Qty./capita Avg use/level of satisfaction

4.3 Information Center Input and Output Measures

In this section we give some numeric examples of input and output measures and operational performance, effectiveness and other derived indicators. These examples are given for 19 principal functions (or services) and a total of 60 activities. These functions and activities are listed below:

Functions/Activities

Collection Development and Management
1. Collection development
2. Collection weeding
3. Physical withdrawal and related housekeeping

Acquisitions
4. Ordering
5. Processing materials received
6. Claiming
7. Cancellations
8. Follow-up

Materials Receiving and Mail Processing
9. Materials/mail processing

Cataloging
10. Copy and enhanced cataloging
11. Original cataloging
12. Journal cataloging (original and copy)
13. Added volume and copy

Catalog Maintenance
14. Catalog additions activities
15. Catalog withdrawal activities

Physical Processing
16. Spine labelling, barcode labelling/linking
17. Other physical processing
18. Monograph binding and repair
19. Acquisitions list

Periodicals Binding
20. Set up of binding records
21. Preparing materials to be bound
22. Processing returned bound volumes

Invoice Processing
23. Invoice processing

Reference Readers Advisory
24. Directional
25. Reference

Online Bibliographic Searching
26. Quick look-up
27. In-depth
28. SDI

Circulation
29. Circulation

Shelving and Reshelving
30. Shelving and reshelving

Interlibrary Borrowing and Lending
31. Interlibrary borrowing
32. Interlibrary lending
33. Items from document delivery services

User Instruction
34. Prepare exhibits
35. Conduct tours and/or present briefings
36. Conduct training sessions/demonstrations
37. Conduct advisory service sessions
38. Other user instruction

Photocopy Services
39. Make photocopies
40. Check-in users
41. Open and close, work at service desk, provide maintenance and supply

Translation Services
42. In-house translation of articles, chapters, etc.
43. Processing and monitoring out-of-house translations

Automated Systems Administration
44. Backup system files
45. Monitor system performance and usage
46. Vendor related activities
47. Staff related activities
48. Reporting

General and Administrative Support
49. Statistical and financial data related activities
50. Secretarial/clerical related activities
51. Professional development and training activities

Management and Administration
52. General administration
53. Planning
54. Financial management
55. Personnel management and staff development
56. Computer, equipment and systems related activities
57. Facilities management
58. Contract services
59. Marketing, public relations, etc.
60. Policies and procedures

There are at least 500 individual activities that have been identified in information centers. It is neither practical nor necessary to record the amount of labor time devoted to this many activities. On the other hand, it is useful to record the time required to perform the three to ten or so basic activities performed by each employee. The basic activities should include the 60 mentioned above, if done by an employee. However, other important activities should be included as well; particularly if they are of interest to the employee's supervisor.

One can structure an information center (such as a library, clearinghouse, etc.) into functions, services and products as outputs of the functions, activities necessary to provide services or produce the products, resource components required to perform the activities and attributes of the resources. These form a hierarchy of sorts as shown in Table 4.4. The library functions are sub-divided into technical or operational functions (e.g., acquisitions, storage, etc.), user related functions (e.g., reference, access to materials, circulation, etc.), and support functions (e.g., management, financial, etc.). The reason for the distinction among these three types of functions is two-fold. First, measures of output attributes and effectiveness are different for them. Second, costs of technical or operational functions are often allocated to user related functions. For example, it is meaningful to allocate costs of acquisitions, document processing, storage, etc. to circulation of materials. The former being fixed costs and the latter variable costs of circulation of materials. Furthermore, costs of support functions might first be allocated across both technical and user related functions.

For each function there are various services provided. For example, for the reference functions there are referral question answering, reference search and Selective Dissemination of Information (SDI). There are services that are often accompanied by physical outputs such as online search computer print-out. The physical outputs are products. Within each service there are many activities that are performed to provide the service. Taking one service, for example, reference searching, there are activities associated with solicited searches (e.g., interviewing users, developing a search strategy, etc.) and with unsolicited searches. In addition, there are general activities that must be performed to be able to do reference searching (e.g., keeping abreast of database sources, reference materials, and vendor services, etc.). There are resources that are applied to perform all of the activities. For example, for conducting searches there are staff (people), equipment, communication services, materials, space and furniture, and supplies that are required. Activities are what is done and resources are what is necessary to do it. Each of these resources require certain attributes to be able to perform activities well. For example, professionals require certain competencies (e.g., knowledge and skills to apply the knowledge). Indicators of knowledge and skills are education, training and experience.

It is noted that every function has distinct services and products, that in turn have many activities, requiring several resources, that have special attributes. Thus, the operations and services of libraries, clearinghouses, and information centers are very complex, but to properly evaluate them one must describe them in the detail depicted in Table 4.4.

TABLE 4.4
STRUCTURE OF AN INFORMATION CENTER

EXAMPLES OF LIBRARY FUNCTIONS	EXAMPLES OF LIBRARY REFERENCE SERVICES & PRODUCTS	EXAMPLES OF LIBRARY REFERENCE ACTIVITIES	EXAMPLES OF RESOURCES FOR CONDUCTING SEARCH ACTIVITY	EXAMPLES OF ATTRIBUTE RESOURCES
Technical Acquisitions Document processing Storage Circulation Recordkeeping ILL Request Placement	Referral	Solicited Interview users Develop search strategy Determine search method Determine source Conduct searches Review results Analyze results Provide results Translate titles/abstracts	People Professional Paraprofessional Equipment Terminals Telephone Photocopying Audio/Visual	Competencies Knowledge Skills
	Question Answering			
User Related Reference Physical Access to Materials Access to facilities User Training	Reference Searching	Unsolicited Develop unsolicited searches Conduct searches Evaluate searches Perform analysis Write summary Prepare public relations strategy Distribute published searches	Communication Service Database Network Vendor Materials Reference materials Search materials Library Procedures Source materials	Background Education Training Experience
Support Management Finance Accounting Personnel Research Technology Staff Training Public Relations	Selective Dissemination of Information	General Keep abreast of sources/services Keep abreast of technologies Attend professional meetings Supervise staff Train staff & users Maintain & report statistics Develop charging strategies	Space & Furniture Supplies	

*Work settings made a part of the project

Chapter 5

Evaluating the Performance of Information Center Staff and Automated Systems

5.1 Background

In this chapter we present two examples of performance evaluation. The first example involves the evaluation of information center staff. In particular, we discuss measuring staff input costs, output quantities and attributes. Some of the examples are also found in *Keys to Success*[4]. Chapter 6 discusses methods for controlling the productivity of staff using quality assurance surveillance methods. The second example discusses the evaluation of automated systems. This example emphasizes the three levels or perspectives suggested in the evaluation framework described in Chapter 2. Some measures and models are suggested.

5.2. Evaluating Staff Performance

Measuring Staff Input Costs

Measuring staff costs associated with specific services can be difficult unless the amount of staff time devoted to services is known. There are many ways to measure staff time, but none are ideal. In fact, different methods are better in different circumstances. Generally, the best method is to allocate staff time to appropriate services and operational functions. The following rules and steps are suggested:

- Allocate staff time only for the amount of time actually spent working at the center (i.e., do not include holidays, sick leave, etc.)
- List all of the services or operational functions of interest. This list could include, for example, the functions and services listed in Chapter 4.
- Design an individual Weekly Time Log (see WEEKLY TIME LOG below).
- Design a worksheet for allocating individual staff time and salaries to services (see STAFF ALLOCATION WORKSHEET below)

Three ways of measuring staff time are:

- Use time sheets or labor logs on an ongoing basis of time spent on specific activities, services or functions.
- Ask staff or their supervisors to estimate the proportion of time spent on specific activities, services or functions throughout a year.
- Observe staff doing various activities at random times during the day. Random alarm devices could be used or a supervisor could walk through the unit at random times and observe what staff is doing.

Interestingly, the three ways of measuring the allocation of staff time to services do not yield greatly different results. An example of the use of time sheets follows.

For the example, assume that there are two staff members (A and B) involved in Reference and Readers Advisory (R & RA) and Online Bibliographic Searching (in addition to other services). The remaining services and functions and other staff are ignored for the purposes of the example. Each staff member is asked to complete a Weekly Time Log (see Figure 9 for a sample). Assume that one staff member spends 1.6 hours on breaks, 6.2 hours on Reference and Readers Advisory (directional queries) and so on. The staff member also spends 3.3 hours on Overhead Activities (e.g., discussions, professional development, etc.) and 7.2 hours on Sick Leave. The total hours spent on specific services and functions can be estimated for an entire year by adding the time logged on 52 Weekly Time Logs or a sample of Time Logs. In some instances the Weekly Time Logs can be kept for sampled periods and extrapolated to a full year.

On the Staff Allocation Worksheet (see Figure 10), services and salaries of specific staff member (A and B) are listed. The worksheets can be designed for all staff or subdivided by specific units or levels of staff depending on the size of the information center staff. The salaries can, and probably should, include any fringe benefits or other forms of compensation. Recorded on the sample Staff Allocation Worksheet for each staff member are (1) hours worked, (2) proportion of hours worked on specific services, and (3) appropriate allocation of salaries. For example, there are about 234 days or 1,872 actual work hours per year (excluding vacation, sick leave, and holidays)

In the example, staff member A has 42 days of sick leave and holidays, 5 days of professional development, about 2 days of breaks, and about 19 days of other overhead time for a total of 68 days (490 hours) of overhead time. This overhead time can be recorded (as an indicator of efficiency) or it can be distributed across the other services and functions. The calculations below demonstrate both methods.

Total staff costs for services are calculated using the following steps:

- The proportion of hours devoted to each service is calculated by dividing the number of hours for each service by the total hours (e.g., 72 divided by 1,872 = 0.038 or 3.8%).
- The staff cost (for staff member A) is calculated by multiplying the total compensation by the proportion of hours (e.g., $30,000 times 0.038 = $1,140).
- The total staff cost is found by adding the costs across staff members (e.g., $1,140+$3,296=$4,436).

The overhead can be allocated across services as follows:

- Calculate the cost rate attributable to overhead: ($30,000) divided by ($30,000−$7,860) = 1.355 for A and ($16,000) divided by ($16,000−$3,520) = 1.282 for B.
- Multiply staff cost of each service by 1.355 (e.g., $1,140 times 1.355 = $1,545 for A and $3,296 × 1.282 = $4,225 for B).

1) TO BE LOGGED IN 0.1 HOUR INCREMENTS; E.G., 0.2, 5.8, 5.5, ETC.

2) A NORMAL WORKDAY IS 7.2 HOURS.

Service/Functions	Mon.	Tues.	Wed.	Thurs.	Fri.	Sat./ Sun.	Total
1. Breaks	0.4	0.4	0 3	0.5	___	___	1.6
2. R&RA: Directional	2.1	1.8	1.3	1.0	___	___	6 2
3. R&RA: Reference	0.5	0.6	0.1	0.2	___	___	1.4
4. Circulation	3 1	4.3	1.5	1.4	___	___	10.3
5. Shelving and Reshelving	___	___	___	2.0	___	___	2 0
6. Photocopy Services	___	___	4.0	___	___	___	4.0
7.	___	___	___	___	___	___	___
8	___	___	___	___	___	___	___
9. Overhead	1.1	0 1	___	2.1	___	___	3.3
10. Other (Specify)							
_____	___	___	___	___	___	___	___
_____	___	___	___	___	___	___	___
11. Hol./SL	___	___	___	___	7 2	___	7.2
TOTAL hrs.	7 2 hrs.	7.2 hrs.	7.2 hrs.	7.2 hrs.	7 2 hrs.	___ hrs.	36.0 hrs.

Month Day Month Day

Dates: Monday ____ ____ to Sunday _____ _____, 1990

Employee Signature _____

Supervisor Signature _____

Fig.9 Example of a weekly time log

PERIOD OF OBSERVATION: _____

Special/ Operational Functions	A Hours 1,872	A Prop. of Hours (%)	A Comp $30,000	B Hours 1,872	B Prop. of Hours (%)	B Comp $16,000	Total Compensation $46,000
Stock Development and Management							
Acquisitions							
Mail Processing							
Cataloguing							
Catalog Maintenance							
Physical Processing							
Periodicals Binding							
Invoice Processing							
Reference & Readers Advisory							
Directional	72	3.8	1,140	395	20.6	3,296	4,436
Reference	299	16.0	4,800	298	15.9	1,544	7,344
Online Bibliographic Searching							
Quick Look-up	102	5.4	1,620				1,620
In-depth	391	20.9	6,270				6,270
Circulation	87	4.6	1,380	521	27.8	4,448	5,828
Shelving & Reshelving				104	5.6	896	896
Photocopying Services				152	8.1	1,296	1,296
Equipment Services							
Public Relations							
Management and Administration	431	23.6	6,930				6,930
Overhead	490	26.2	7,860	412	22 0	3,520	11,380

Fig 10 Example of a staff allocation worksheet

- Add new staff costs (e.g., $5,770 for Directional Query Service).

To determine staff time and costs it is suggested that supervisors establish about three to ten basic activities for each staff member to be included on the log sheet. A combined log (i.e., a log that combines input time and output quantities) can also be used, if preferred. The activities given on the Weekly Time Log (see Figure 9) sheet are presented as examples. Items 2—9 could be left blank for supervisors to fill out for each staff member. Supervisors should determine which activities to record for each of their staff members. Generally, all of the 60 activities listed in Chapter 4 should be covered at minimum. Other activities to be included should be those that involve substantial time or that the supervisor is interested in monitoring over time. The amount of time devoted to various activities can be monitored over time to establish trends in the way in which staff members devote their time, particularly for activities that do not deal directly with specific user services (e.g., acquisition or document ordering) or those related to specific output (e.g., number of items originally catalogued). Otherwise, the input measures will be related to output measures to establish operational performance indicators.

The Weekly Time Log should be completed each day to the staff members' best abilities. Each day should include 7.2 hours for full-time staff. Time should be recorded to the nearest 0.1 hour to add up to 7.2 hours each day. Each week staff members should hand in a log that they have signed or initialled (at the bottom of the form) If absent, the staff members should complete the logs on their return. Staff should also record the total amount of time for the week for each activity worked on during the week (i.e., row totals). Staff costs will be determined by multiplying individual staff hours times staff rates (i.e., salary plus overhead divided by 1,872.) This can easily be done if a spreadsheet program is available.

All appropriate resources should be identified for each activity and cost to be measured for resources and staff activities. Suggestions for recording these data are given in the following example. The sample spreadsheet format in Figure 11 can be used as a guide.

Measuring Costs of Other Resources

Cost finding is more difficult for non-staff resources. Many times it is best to estimate the cost of an activity on an item-to-item basis (e.g., total vendor invoices for online bibliographic searches; cost of photocopies, etc. for online searching). Other times the costs of some resources (e.g., computer system, postage, some supplies, etc.) can be established for services by allocating their total costs across service items. Such resource costs can be derived from line items in the information center's budget.

Fixed costs may require depreciating expenditures over time. It may also be necessary to allocate the depreciated costs to activities. Depreciation involves spreading capital expenditures for such items as computer systems, microform reader/viewers, other equipment, facilities, etc. over a useful period of life. If equipment and other similar expenditures have not been depreciated, the steps mentioned above provide a method for doing so.

Once a resource item's cost for a year is determined, it may be necessary to allocate the cost across two or more activities, since expenses for some resources or items might apply to more than one activity. Examples include depreciated computer system costs (e.g., $4,000 per year), annual fees, total postage costs, etc. In these instances, the costs must be allocated between variable and fixed costs. Suggested steps for making such allocations are:

- Design an allocation worksheet (see Figure 12 OTHER RESOURCE ALLOCATION WORKSHEET).

Function/Activity	Staff			Computer System/ Equipment, etc.		External Services	
	Staff Member	Hours	$	Items	$	Items	$
Make photocopies	1	1,567	$11,752	Photocopiers	$ 8,809	None	
	2	462	$ 3,615	Maintenance	$ 656		
	3	108	$ 934	Other	$ 524		
	TOTAL		$16,301		$ 9,989		

Facilities		Postage, envelopes, Supplies, etc.		COLLECTION		Other Resources		TOTAL
Items	$	Items	$	Items	$	Items	$	$
408 # ft.	$10,473	Paper	$ 4,081	Allocation of	$30,400	None		
Furniture	$ 58	Toner	$ 326	collection use				
		Other	$ 211					
TOTAL	$10,531	TOTAL	$ 4,618		$30,400			$71,839

Fig.11 Spreadsheet for displaying direct input costs of activities

	TOTAL $	COMPUTER		TERMINALS		ONLINE VENDORS		OCLC FEE		POSTAGE	
		%	$	%	$	%	$	%	$	%	$
TOTAL COSTS	$43,500	100%	$4,000	100%	$8,000	100%	$18,000	100%	$1,500	100%	$12,000
INDIRECT COSTS											
Overhead & Admin.	$10,400	70%	$2,800	5%	$ 400	0%	0	0	0	60%	7,200
Other	$ 1,560	5%	$ 200	2%	$ 160	0%	0	0%	0	10%	$ 1,200
COMPUTER SYSTEM											
Computer	$ 1,000	25%	$1,000	0%	$ 0	0%	0	0%	0	0%	0
DIRECT COSTS											
Online - Variable	$20,400	0%	0	0%	$ 0	100%	$18,000	0%	0	20%	$ 2,400
Online - Fixed	$ 4,000	0%	0	50%	$4,000	0%	0	0%	0	0%	0
Cataloging - Variable	$ 600	0%	0	0%	0	0%	0	0%	0	5%	$ 600
Cataloging - Fixed	$ 2,740	0%	0	23%	$1,840	0%	0	60%	$900	0%	0
Interlibrary Loan - Variable	$ 600	0%	0	0%	0	0%	0	0%	0	5%	$ 600
Interlibrary Loan - Fixed	$ 2,200	0%	0	20%	$1,600	0%	0	40%	$600	0%	$ 0

Fig 12 Resource allocation worksheet

- For each cost item (i.e., resource) establish a reasonable basis for determining the proportion of costs that should be allocated to each service. For example, computer depreciation costs can be allocated on the basis of relative time used for services, postage can be allocated by number of items sent for the services, etc.
- All computer time can be allocated, or if idle time is known, the idle time can be allocated as well, depending on one's ability to determine proportion of time (see the previous section on allocation of staff overhead cost).
- Proportion of costs for each cost item should be calculated and recorded.
- The costs of each service can be estimated by multiplying the total costs times the proportion (e.g., 0.70 x $4,000 = $2,800 for computer).
- Total other resources cost associated with a service can be found by adding across cost items for each service.

Costs expressed in terms of monetary units (dollars) provide a common unit of input for all resources (and services).

A sample spreadsheet for displaying input costs and output quantities was given earlier in Figure 11. The service in the example on the sample spreadsheet is Making Photocopies, and the resources used for the service include staff, photocopying equipment, facilities, supplies, and the collection. Allocation of collection costs is not normally done, but there are philosophical reasons for doing so if desired. The total cost across all resources for this service is $71,839. Cost per document photocopied is $0.90 per document copy and cost per page is $0.098 per page. Methods for measuring output quantities are discussed in the next subsection.

The costs of all resources are affected by the attributes of resources (e.g., the experience of staff, the storage capacity of computers, etc.). The spreadsheet program should record important attributes such as the staff level (i.e., professional, paraprofessional, clerical support, etc.) and salary scale. In this way, staff productivity can be observed at several levels: individual staff productivity, productivity of each level of staff, productivity of all staff in the unit (department/group, etc.). It is not necessary to measure the attributes of other resources on an ongoing basis unless current decisions regarding such attributes are to be made. If, for example, a decision to purchase new equipment is required, then one can establish the effects of the various attributes of current computer systems, microcomputers, terminals, photocopiers, facilities, etc. on the service outputs.

Measuring Service Output Quantities and Attributes

Service output is measured in terms of quantities produced, quality, timeliness, etc. There are a number of ways in which work output can be measured, although many activities simply to do not lend themselves to specific output quantities (nor to quality or timeliness for that matter). Quality can be observed by supervisors' (or someone else qualified to check quality) random inspection of output of someone's work. Timeliness can be observed by 100 percent observation of events or by random spot checks. Many of the output quantities should be measured as a matter of course. Materials purchased, interlibrary loans, reference inquiries handled, etc., should all be quantities that are kept routinely. Table 4.1 in Chapter 4 listed basic services and activities of an information center together with suggestions for output measures.

Output quantities can be measured by individual staff members. For example, a weekly output log can accompany the weekly time log for some activities. A sample weekly output log can be found in Figure 13. On the log are output quantity measures and blank spaces for recording the amounts for each day of the week. Supervisors will have to determine which output quantities to collect in this manner and then record the appropriate output quantity measures on the form. The dates of data collection and signature for both employees and supervisors should be obtained.

There is some merit in recording output quantities along with input times so that employees get a sense of their own productivity, especially if recorded on a daily basis as suggested. It can be eye-opening for employees to have to record these data.

Service output attributes include quality, timeliness, availability and accessibility of services and operational functions. Service output attributes are generally more difficult to measure than service output quantities. Methods are described in Chapter 6 for measuring service output attributes.

5.3 General Approach to Evaluating Information Center Automated Systems

The approach discussed in this section relates the evaluation of an automated system to its role in supporting the mission, goals and objectives of the center, and therefore, the center's parent organization as a whole. Our approach to the evaluation of automated systems involves three levels (or perspectives):

- Automated system level
- Information center
- Organization level

The object of evaluation in this example is the automated system. However, we have found it very important to consider the total environment within which an automated system operates; otherwise, one might make decisions concerning automated systems without regard to how the system actually affects the information center, its users, and the organization being served. Furthermore, the objective of developing a methodology to address future directions for the center's program efforts can not be properly achieved without evidence concerning all three levels.

Below we describe in more detail what is meant by the three levels of evaluation and why evaluation is performed in this way. Later in this section we describe how the various measures and models can ensure that the automated system helps the center fulfill its role within the organization.

Evaluation from the Automated System Level Perspective

The automated system can be evaluated from a series of interconnected perspectives. First, the system can be evaluated in isolation from its environment. This type of evaluation is done in "benchmarking" different automated systems' performance against some standard measure of performance. In these cases, each system being evaluated against the benchmark is made to operate under the same environmental conditions and constraints. The automated

RECORD AMOUNT OF OUTPUT EACH DAY - COMPLETED WORK ONLY

Output Quantity Measures	Mon.	Tues.	Wed.	Thurs.	Fri.	Sat./ Sun.	Total
1. R&RA: Directional	___	___	___	___	___	___	___
2. R&RA: Reference	___	___	___	___	___	___	___
3. Circulation	___	___	___	___	___	___	___
4. Shelving and Reshelving	___	___	___	___	___	___	___
5. Photocopy Services	___	___	___	___	___	___	___
6. _____	___	___	___	___	___	___	___
7. _____	___	___	___	___	___	___	___
8. _____	___	___	___	___	___	___	___
9. _____	___	___	___	___	___	___	___
10._____	___	___	___	___	___	___	___
11._____	___	___	___	___	___	___	___
Total	___	___	___	___	___	___	___

Dates: Monday Month _____ Day _____ to Sunday Month _____ Day _____ 1990

Employee Signature _____

Supervisor Signature _____

Fig.13 Examples of a weekly output log

systems are generally "emptied" of all unnecessary data and programs, except those that are needed to conduct the evaluation. A predetermined number of data records in a predetermined format are usually loaded, together with a program that will perform one or more operations on the data. The program is then run for either a predetermined time period or for the time necessary to perform a function (in which case the time taken to perform those operations is measured). In either case, the performance of the system is measured in terms of "quantities produced per time interval".

The types of evaluations range from the very simple such as number of additions performed per minute, or time taken to sort a list of N items; to the rather sophisticated, such as the number of predetermined, simultaneous user transactions that can be performed in an hour. Nevertheless, what distinguishes this level of evaluation from another level is that the system is evaluated against other systems independently of the environment in which they are operated. Such evaluation is useful for the following purposes:

- evaluating the "compute power" of an automated system against other systems (this can include other systems of the same manufacturer or vendor, or other systems performing similar functions)
- evaluating whether or not the computer configuration being evaluated can cope with anticipated workloads (at both normal and peak operation)
- providing a baseline of performance against which various operational mixes can be evaluated (a nearly "empty" machine being as close to an "ideal" environment as possible).

In addition to such automated system performance measures mentioned above, one can also look at other automated system components as well, such as the information content or form. These components also affect system use, effectiveness and higher order effects.

Evaluation From the Information Center Perspective

Another level of automated system evaluation is from the perspective of the organization within which it operates. At this level the evaluator would be concerned with how well the system supports both the day-to-day operation of the information center and the needs of users of the center. Both the center staff and center users are users of the automated system. Some system functions (or modules) are used only by center personnel (such as cataloging or circulation), whereas others are used by both staff and users (such as an online catalog). Thus, an evaluation would be conducted at this level according to the specific function/module, and according to the type of user (i.e., staff or user). The evaluation at this level relates how well the system performs in supporting the particular function and how effective the system is to its users. We think of performance in such terms as output quantities produced, quality and timeliness. For example, the performance of an automated cataloging system could be measured in terms of the time taken to input a complete bibliographic record, or the time taken to input an item/holdings statement, or the number of records that could be input per hour, response time, etc. On the other hand, effectiveness is measured from the perspective of the user of the system in such terms as amount or frequency of use, amount of repeated use, user satisfaction, etc. Other factors that relate to effectiveness include ease of use of both procedures and equipment, physical comfort of the workstation/terminal and display, availability of system help messages, availability of other forms of assistance (such as center staff assistance to center users), etc.

Evaluation From the Organizational Level Perspective

Often the mission of an information center is to provide comprehensive support to the parent organization to achieve its mission. To any extent that an automated system helps the information center to fulfill the mission, it also helps the organization to achieve its more global mission. Thus, this third level of evaluation would relate the use of the automated system to the use of the center, and the use of the center to the work of the professionals it serves. Evaluation studies of this type should demonstrate not only the immediate effects of system use but also the extent of subsequent or higher-order effects.

Linking the Three Levels of Evaluation

The general approach to evaluating the automated system is displayed in Figure 14. Across the top of the figure are several related aspects:

- hardware/software components
- machine performance
- system factors
- system attributes/variables
- system effectiveness
- higher order effects/consequences of system use

The first four aspects correspond to the automated system level referred to previously, the system effectiveness to the information center level and higher order effects/consequences of system use to the organizational level. The arrows indicate that one aspect affects the next one. That is, hardware/software components affect machine performance, which affects certain system factors which affect system attributes (or variables), which affect system effectiveness, which affects consequences of system use.

The system hardware/software components include CPU, internal memory, external memory, functions/modules, indexing structure, and communications. The machine performance of quantities processed, processing time, response time, etc., clearly depend on these components (as well as other components such as vendor). Furthermore, the functions (or modules) supported by the system are an important system factor and the degree to which the overall system performs is dependent on these functions. System effectiveness depends on several system attributes of the function/module factor. Such attributes are the quantities of information available, quality (accuracy and precision), currency of information, timeliness of response, cost and so on.

We suggest grouping system factors and their attributes together because the information center has some direct influence on them through system configuration and management modifications.

In addition to functions/modules supported, another factor over which the center has control is promotion, which affects user awareness, perception and understanding of the system; all of which partially contribute to system use and effectiveness.

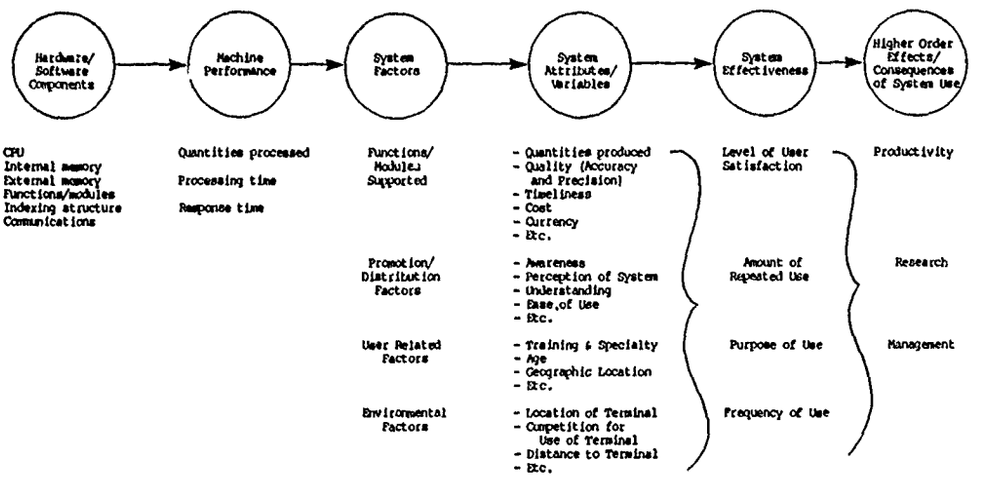


Fig.14 KRI evaluation model

There are some system factors which cannot be influenced directly by center or organization personnel, but knowledge of which can be very helpful because of their indirect effect on use. These include user-related and environmental factors. User-related variables include the education, training and specialty of users, their exposure to and use of automated systems, and age. Evidence suggests that frequency of use of automated systems is related to such variables. Similarly, environmental factors such as location of terminals and visibility of terminals to users also affect system use.

One approach to this level of evaluation is to measure and evaluate system attributes and variables and to develop models for estimating the relative contribution that they make to the use of the system and then to the consequences of system use.

Most evaluations merely measure either attributes and user satisfaction, or frequency of use. The power of models for actually linking attributes with frequency of use is that they estimate the relative contribution that attributes, such as cost (to use), timeliness, quality, etc., make to frequency of use. Thus, decisions can be made concerning functions/ modules supported and promotion alternatives based on both cost and effectiveness (in terms of amount of use of the system).

Frequency of use per se does not totally indicate system effectiveness. One must consider higher order effects as well. Obviously, improved user productivity, better research and more effective management are important consequences of the system. It is very useful to determine the effectiveness of information systems by estimating the cost and benefits of systems by comparing the current system with alternative methods of obtaining information (or alternatives to not having the information). Such comparisons are made at all the levels mentioned above; that is, system attributes, frequency of use, and consequences of use. At each level, if the comparison is favorable it is counted as a benefit and if it is unfavorable it is counted as a cost (or, perhaps more appropriately, a detriment). As the levels aggregate it becomes more and more difficult to measure and/or model so that it may be necessary to make comparisons in non-quantifiable terms.

Finally, in this evaluation approach it is assumed that the mission of the automated system is in some way related to the higher order effects/consequences of the system. The goals of the system are broad statements of ways in which the mission can be achieved. System objectives can be stated in terms of system use or effectiveness. Within each goal are a set of such measurable objectives. Then, using the evaluation approach set forth in this chapter, one can also make decisions on the basis of how they affect objectives, goals, and mission of the information center.

Details of the Automated System Evaluation

As mentioned above, there are many factors that contribute to the use and usefulness of a system such as an automated system. The information center has direct control over some of these factors through, for example, system design modifications. With other use-related factors, the center can only take indirect actions such as by training programs. Below we sub-divide the system factors into groupings that imply different levels of solution or action that can be taken. Associated with each of these system factors are attributes or variables that can be measured and which can be used in models for estimating purpose and amount of use, or effectiveness. The models can also determine the relative contribution each attribute makes to the frequency of use of the system. The listing of potential system components and their attributes are given in Figure 15.

Information is sub-divided into two principal components: information content and information form. Information content is the actual message which is being conveyed. Attributes related to information content include accuracy and precision (i.e., the "dosage" of information content: is it too much or too little?). Other attributes related to use and usefulness are currency, completeness, and availability. The second information component, form, includes the format of the information, the structure, and medium (e.g., electronic, paper, microform, etc.). Together the different aspects of information form comprise the "package" used to communicate the information content. Examples of

I. Functions/Modules Supported

Information Content	Accuracy Precision Currency Completeness
Information Form	
Format Structure Medium	Timeliness Accessibility Availability
Access mechanism	
Hardware Software Communications	Response time Resource utilization Ease of use Flexibility

Fig.15 Relationship of functions/modules supported factors and system attributes

attributes of information form are given in the figure and include accuracy, precision, timeliness, and accessibility. As a matter of further clarification, we also link of the information content along with purpose of use as user information needs, and the attributes associated with information content and form are user information requirements. Both are essential to evaluating system effectiveness and value.

In addition to the content and form the automated system includes an access mechanism. One major component of this mechanism is hardware/software used to provide user access to the automated system. This includes computers, computer storage units, and various other peripheral devices, such as terminals, printers, modems, and controllers. The hardware/software employed can seriously affect ultimate system performance and system effectiveness. Other hardware considerations affecting system performance and effectiveness are the types of communications lines supported by modems, the amount of internal memory in the computer supporting the database, etc.

Another component of the access mechanism is the communications infrastructure which supports user interaction with the database. The nature and extent of this infrastructure, measured in terms of type of communications line (direct dedicated, dial up, voice-grade, data lines, hardware, etc.), can also affect system performance and effectiveness. The speed of data communications can affect the speed of response of the system (as will some of the hardware attributes).

The components, hardware/software and communications, comprising the access mechanism should be evaluated in terms of how they affect system performance and effectiveness. For example, output attributes can be measured in response time, flexibility of the user interface, ease of use of the user interface, efficiency of system resources utilization. These system output measures can be related to effectiveness through correlation with frequency of system use, purpose of use, user satisfaction, and so on. Alternatives that might be developed to improve performance and/or effectiveness include the possible development of multiple user interfaces (for example, one for experienced users and one for occasional users, or one for specialists and one for non-specialists) to improve flexibility and use of the system.

Promotion of information systems, services or products can be evaluated in terms of their attributes, effects on frequency of use, and higher order effects. Presumably, the objectives of promotion are also to increase the use and effectiveness of the automated system and achieve it goals and mission. One can subdivide promotion into public relations and price (see Figure 16). There are many ways that public relations can be achieved including exhibits at the center, flyers, or newsletters sent to users.

Promotion

Public Relations	
Exhibits Newsletters Flyers Direct contacts	Awareness Perception of system Understanding Recall Number of contacts Themes
Price	
Exchange of monies	Dollars
Other Costs User Time	Labor time

Fig.16 Relationship of promotion factors and system attributes/variables

Normally price or cost of use are included as an attribute (e.g., in conjoint trade-off analysis), but we included it here as a component of promotion. The reason that we normally evaluate price as an information service attribute is that users pay for both the information content and information form (i.e., value added by improvements in attributes of format, structure, and medium). Thus, we have found it very useful to determine the trade-offs to users in terms of what they are willing to pay for various levels of quality, timeliness, etc. In the automated system, the "price" paid for information content is the time and effort users expend in gaining access to, assimilating and using information. We have found with bibliographic information systems, that the "price" is sometimes too high to pay. Thus, users either use intermediaries or simply do not get the information (see Chapter 9).

There are a number of user and environmental factors that can be correlated with purpose of use and frequency of use of the automated system. There are some user-related factors that link information content and form to frequency of information use. For example, certain ways of expressing meaning varies by specialty and age. Certainly, experience in using various media is linked to age. These relationships are shown in Figure 17.

There are several important or potentially useful user-related factors that might be used in evaluating such as age and resistance to new technology. We have also found that there are a number of environmental factors that are related

to frequency of use in systems as well. The most important such environmental factor is the location of terminals and, relatedly, visibility of the terminal to users, distance (in time) to the terminal and availability of a terminal based on competition for its use.

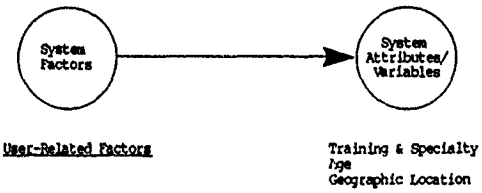


Fig.17 Relationship of user related factors and system attributes/variables

Over the years we have made a definitional distinction between system performance (e.g., output quality, quantities produced, timeliness, etc.) and effectiveness which measures the consequences of the system. Design and other system decisions can directly affect output attributes, but one must assume that higher quality, faster response, etc. will have positive effects such as greater user satisfaction, more frequent use and positive higher order effects such as use of primary materials and how that affects work. Later we will show how to determine, through models, the extent to which output attributes affect frequency of use. Here we discuss examples of measures of first order effects of the automated system.

The first effectiveness measure is user satisfaction (see Part 3). Here system users are asked to indicate their satisfaction with system performance such as with system response time, accuracy and so on. These measures are made by employing Likert like scales (1 to 5). Then, actual measured attributes are correlated with user satisfaction. For example, one should be able to obtain measures of system response time and user satisfaction. System response time can be observed generally with the controlled system enhancement and experimentation and correlated with general observations of satisfaction with this attribute. However, if possible, critical incidents of use should be employed to directly correlate observed response times with the satisfaction indicated in a user survey.

Frequency of use is partially dependent on user satisfaction However, we have found that both measures of effectiveness should be observed, over time. One reason is that increased frequency of use over time can be misleading, if for example, there is a great deal of initial trial (or learning) of a system as may be the case with the new automated system. For this reason, we also like to measure "trial and repeat" use of systems. Secondly, declining use does not tell why the system is being used less. One can often determine why by analyzing user satisfaction with specific performance attributes and the actual attributes measures.

In addition to frequency of use it is important to determine purpose of use. This is necessary because certain performance attributes may be important to specific purposes of use. An extreme example is that speed of response, accuracy of information, content, and highly precise information is absolutely necessary sometimes. Such levels of performance attributes are not necessary at other times or for some users. Purposes of use are related to the value that is derived from information use.

All of the principal measures of automated system first order effectiveness should be observed: user satisfaction with specific performance attributes, repeated use, frequency of use and purpose of use. Specifically which performance attributes and purposes of use to be employed in the evaluation should be determined early in the project. The uses can be sub-divided into meaningful categories depending on relationship to both performance attributes and likely higher order effects. Such categorization can be determined by a combination of prior work at the center, experience with similar systems, review with knowledgeable experts, and literature. All of the measures chosen for the evaluation should be incorporated into models of these relationships, if possible.

The true justification for information system expenditures is higher order effects achieved as a result of using the system. Higher order effects can be observed and measured by either asking professionals to indicate what these effects are, or by observing user behavior over a period of time. Either way, the estimates are usually "soft" because of the many other factors that contribute to user behavior. We have found that observing specific critical incidents of use (chosen randomly from a set of uses over a specified time period) provide much better analytical results than asking general questions about information use and its consequences. For survey purposes, this permits the users to focus on specific performance attributes, satisfaction, purpose of use, and consequences. This also provides a much more statistically sensitive correlation of these measures. It is anticipated that such observations will come from the users as well as online surveys.

There are several powerful models for linking information system attributes to frequency of use (Figure 18). Which of these models should be used for the automated system evaluation depends to some degree on the evaluation plan. The first of these models is a conjoint measurement trade-off model. This model, in effect, establishes the relative importance of system attributes such as quality, timeliness, response time, etc. The conjoint method involves a questionnaire and interviewing technique that forces users to make choices between levels of pairs of attributes. Value "utilities" are derived from these user choices to indicate the relative importance of all the attributes (and their level) or compare several attributes against one such as cost to use One can then correlate the utilities of the attributes with frequency of use (of an information product). Our greatest success with the conjoint measurement method has been with critical incidents of use rather than with general comparisons of attributes. This is because every single use varies in terms of relative importance of attributes (see Chapter 11).

Examples of conjoint measurement analysis include: online and manual bibliographic searching (two different systems), products involving catalog subject authorities, document delivery systems (i.e., distribution of journal article copies). Examples of the important attributes of these information systems are relevance of output, number of items retrieved, speed of delivery and price (bibliographic searching), frequency of publication, publication medium, cumulative or not, and price (for the subject authority product), and speed of delivery, reproduction quality, availability of special graphics or not, and price (for the document delivery system). In each instance, the trade-off analysis can be done for different user population segments or for comparison of

several attributes against one specific use. Data collection methods included self-administered questionnaires and telephone interviews. Another kind of trade-off analysis can be performed using disaggregated multiple regression models. This modelling technique has the advantage over conjoint measurements of incorporating both product attributes as well as other factors such as user and environmental factors. For example, for scientific journals, we determined the relative contribution that (1) quality of journals, (2) number of articles, (3) price, (4) whether a journal is part of a professional society membership or not, (5) availability in information center, and (6) distance to information centers makes to personal subscription to journals. The problem with this technique is that it is very expensive.

Another model involves cluster analysis. A form of cluster analysis is market segmentation or multi-dimensional scaling to determine groups of users (grouped by their attributes) that are more likely to use systems such as the automated system. The problem with the way researchers analyze market segments or clusters is that these clusters are not then related to frequency of use. By using multiple regression modelling (or disaggregated multiple regression analysis) three linkages can be made. For example, the dependent variable can be frequency of use and the independent variables can be system component attributes, promotion attributes, environmental attributes and user related attributes, promotion attributes, environmental attributes and user related attributes determined from cluster analysis.

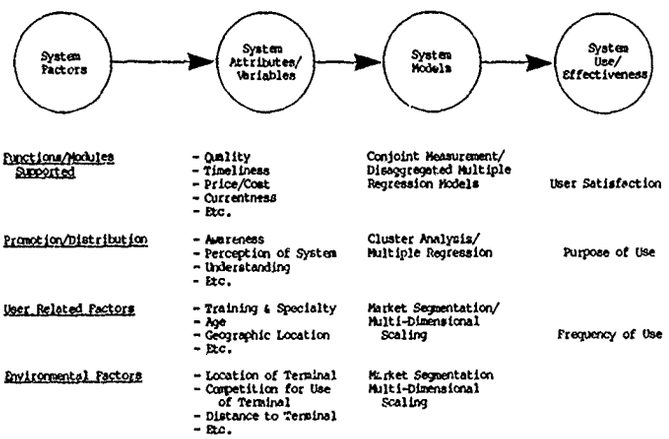


Fig.18

Chapter 6

Quality Assurance Surveillance of Information Center Operations

6.1 Background

Chapters 3, 4, and 5 discuss evaluation of the performance of information center operations and services. In particular, we discuss performance evaluated from the standpoint of input costs and attributes, output quantities and attributes, and relationships between input and output. Information center funders and managers are becoming increasingly concerned with controlling productivity and performance of operations. For example, all Federal libraries and information centers in the U.S. subject to OMB Circular A-76 are required to operate under a formal Quality Assurance Surveillance Plan (QASP). This procedure ensures that acceptable levels of staff productivity are achieved for relevant functions or activities. In this chapter we provide a brief description of measures and methods that might be used for Quality Assurance Surveillance.

In this chapter we describe measures of individual performance of information center staff. The performance measures deal primarily with services to users involving specific or identifiable center user services (e.g., online database searching, interlibrary borrowing, translation, etc.), operational functions that involve a high degree of professional or intellectual work (e.g. cataloging), or production-like activities (e.g., shelving, photocopying, etc.). Below we list some functions and activities for which we recommend maintaining measures of performance and we present examples of acceptable levels of performance. Following that we provide suggested methods for observing and controlling (in a quality assurance sense) performance of staff. Note that the process should be an evolving one in which measures are observed and changed to reflect the practical aspects of knowledge work. Clearly, performance ratings must go beyond the data collection suggested here, to make sure the measures are fair, feasible, and practical. The suggestions below may go beyond what an information center might ultimately arrive at. However, they can serve as a beginning from which to work.

6.2 Performance Levels of Activities and Functions

The principal methods of Quality Assurance Surveillance involve traditional quality control (QC) procedures. There are several aspects of these procedures that one must thoroughly understand. Below we discuss these aspects and give several examples for each:

- *Functions or activities being observed*
  - online bibliographic searching
  - original cataloging
  - collection development and management: selection of materials
- *Units or transactions measured*
  - *full searches* of online bibliographic databases
  - *items (e.g., books) originally cataloged*
  - *items (e.g., books, journals, etc.) selected* by the collection development process.
- *Output attributes measured*
  - *number of days for delivery measured from a negotiated delivery date* of full searches of online bibliographic databases
  - *quality* of original cataloging
  - *relevance* of items selected by the collection development process
- *Acceptable quality levels*
  - full searches *delivered within one working day* of negotiated delivery date
  - items should be originally cataloged to *center conformance standards*
  - Items selected by the collection development process should meet *center conformance standards* of relevance
- *Rejection criteria*
  - No more than 5 percent of the search results should be delivered beyond one day of negotiated date of delivery.
  - No more than 10 percent of items originally catalogued should fail to meet quality conformance standards.
  - No more than 10 percent of times selected should fail to meet conformance standards of relevance.
- *Methods of surveillance*
  - Review records monthly to see that full searches are performed within acceptable times (i.e., 1 day of negotiated delivery date).
  - Sample 20 items originally cataloged every quarter. The sample catalogs are inspected to ascertain that original cataloging conforms to center quality standards.
  - Sample 100 items selected by the collection development process each year. The sampled items are inspected to establish that they meet center relevance standards.

Note that the last two methods of surveillance above involve samples. More detail concerning Quality Control (QC) sampling is given in the next section. In these instances the estimates of proportions which do not meet standards are subject to sampling error. Thus, some latitude is provided in the sampling to minimize the risk of rejecting work when, in fact, it is acceptable. Procedures are discussed in the next section for how this is done.

The QC procedures require that rejection of work output be based on a proportion of units of output (or transactions) which do not meet acceptable quality levels. This method assumes that the information center can develop meaningful and relevant conformance standards. Many of the information centers we have worked with have developed such standards. One can also set rejection criteria on other operational performance measures as well, such as

productivity. Examples of acceptable levels of productively might be two titles originally cataloged per hour or eight invoices processed per hour. It is useful, if possible, to set productivity levels at different acceptable levels of quality.

Below we list examples of functions and activities for which one might observe performance measures. For each one we also provide suggested measures and the basic method of observation.

Collection Development and Management

Review and select materials

1. Items selected by the collection department process should meet center conformance standards of relevance. No more than 10 percent of items selected should fail to meet conformance standards of relevance.
2. Survey users annually to determine level of satisfaction with collection scope, comprehensiveness, and relevance.
3. Annually review circulation records and in-house use to see which items are never used. Establish that there are no more than 10 percent of the items (acquired in the last two years) that are never used.

Review and select materials for withdrawal

1. Review items recommended to be withdrawn and establish that fewer than 10 percent are judged not appropriate for withdrawal.

Acquisitions

Acquisition of monographs, serials, etc.

1. Normal orders should be placed within five working days of request, 98 percent should be placed within five working days and none over ten working days.
2. Rush orders should be placed within 48 hours of request.
3. Normal receipts should have immediate notification and receipts processed within the hour. All rush materials should be processed within one day.
4. Rush receipts should have immediate notification and receipts processed within the hour. All rush materials should be processed within one day.
5. First order items should be claimed within two months of date ordered and monthly thereafter. No claims should extend beyond two weeks of specified time.
6. Claiming of serials issues should be made within one week of identification of overdue date and monthly thereafter.
7. 95 percent of continuing serials issue receipt should be checked in within one day of receipt and 100 percent within two days
8. Productivity of ordering and order control processing should be 5 items per hour.

Materials Receiving and Mail Processing

Materials handling

1. Incoming materials should be processed and delivered within one day of receipt. All items should be processed within two days.
2. Productivity of mail processing should be 10 normal mail items per hour and 4 packed items handled per hour.

Copy and Enhanced Cataloging

1. Items should be copy-cataloged and enhanced to information center conformance standards. No more than 5 percent of items should fail to meet conformance standards.
2. Productivity for copy cataloging should be 4 titles per hour.
3. Throughput time should be less than 5 days. No more than 5 percent of titles should take more than 5 days.

Original Cataloging

1. Items should be originally cataloged to information center conformance standards. No more than 5 percent of items should fail to meet conformance standards.
2. Productivity for original cataloging should be 2 titles per hour.
3. Throughput time should be less than 5 days. No more than 5 percent of titles should take more than 5 days.

Cataloging Maintenance

1. Review items and card files and dispose of items and/or cards within one week of notification.

	2. Resolve authority conflicts within one week of identification. 3. Update automated catalog/shelflist, authority file, etc. at prespecified times. 4. Productivity for catalog additions should be 2 titles per hour.
Physical Processing	
Spine labelling, bar code labelling/linking	1. Productivity should be 8 titles per hour.
Other physical processing	2 Productivity should be 25 items per hour.
Prepare materials for binding and repair	3. Prepare materials within one week of notification by supervisor to do so.
Periodicals Binding	1. Review within one week of schedule. 2. Send to bindery within one week of review 3. Shelve within one day of return to center.
Invoice Processing	
Prepare invoices for payment and payment document	1. Prepare within one week of receipt. 2. Productivity should be 8 invoices processed per hour. 3. Productivity should be 40 invoices per hour.
Online Database Searching	1. Full searches delivered within 1 working day of negotiated date of delivery. No more than 5 percent of full searches should be delivered after 1 working day of negotiated date of delivery. 2. No rush searches performed beyond negotiated day of receipt. 3. 95 percent of user satisfaction ratings at satisfactory or above for relevance of response; response time; and number of items retrieved
Selective Dissemination of Information	1. Searches performed within two weeks of scheduled time. 2. 95 percent of user satisfaction ratings at satisfactory or above for relevance of response; response time; and number of items retrieved
Circulation Activities	1. Surveys should establish that fewer than 5 percent of the users are dissatisfied or very dissatisfied with speed of response at circulation 2. Random spot checks should establish that check-in and check-out are done expeditiously and unnecessary queues do not form
Translation	1. No more than 2 percent of translations completed more than 10 days beyond negotiated time. 2. No more than 1 percent of rush requests within two days beyond negotiated time. 3. No more than 2 percent of user ratings less than satisfied or very satisfied for response time, accuracy of translation, etc
Shelving and Reshelving	1. Productivity of shelving should be: 125—150 volumes per hour (bound journal volumes), 150—175 issues per hour (loose unbound issues). Sorting productivity should be 5 to 10 minutes per truck (depending upon size of truck). 2. No more than 1 percent of ILL or circulated items shelved incorrectly.
Interinstitutional Borrowing and Lending	
Interinstitutional borrowing	1. No more than 10 percent of normal borrowing requests should be processed in more than 1 day. 2 All rush requests should be processed within 48 hours. 3. Productivity of requests fulfilled should be 50 requests per hour (not including photocopying).
Interinstitutional lending	1. No more than 10 percent of lending requests processed in more than 3 days. 2. Productivity should be 25 initial requests processed per hour and 4 lending items fulfilled per hour.
Photocopying	! Productivity of photocopying should be 30 articles per hour. 2. No more than 2 percent of user ratings less than satisfied or very satisfied for response time and quality of photocopy.

6.3 Data Collection Methods for Quality Assurance Surveillance

Data collection for staff performance evaluation is conducted to help ensure that sufficient levels of performance are achieved. To do this we suggest that several measures be observed including: productivity, timeliness of services and quality of some activities and services. There are essentially six methods employed in rating staff performance, as follows:

1. *Observation of Productivity.* Productivity is measured by the number of items produced per work hour. Output quantities may be observed by logs or other means over a specified period of time (e.g., one month or quarter) and corresponding input hours observed by logs, diaries, random observations, etc.
2. *100% Inspection or Observation of the Timeliness with Which Activities Are Performed or Services Provided.* Timeliness is determined by recording when events take place. Standards for the timeliness of an activity are based on a proportion of events that are to be accomplished within a specified time period. For example, acceptable performance might be that no events be accomplished beyond specified time or fewer than 3 percent accomplished beyond specified time or fewer than 3 percent accomplished beyond that specified time. All events (100%) would be observed to make sure that acceptable levels of standards of timeliness are achieved.
3. *Random Sampling of Output.* In most instances, individual observations of performance are difficult or expensive In these instances, the output of activities is sampled and inspected for timeliness or quality.
4. *Random Spot Checks.* Spot checks ascertain that some activities are being performed as specified. For example, the circulation desk might be observed at random times to insure that it is manned, large queues have not formed, and users are being served properly, etc. A spot check performed weekly or monthly can verify that this is happening.
5. *User Feedback Including User Surveys.* A survey of users may be done in order to ascertain that performance standards are being met (e.g., that a standard for reference timeliness and quality is maintained from the user perspective). See Part 3 for in-depth discussions of user surveys.
6. *Validated User Complaints.* User complaints should be encouraged. They should be received and verified as a means of assuring quality of work performed. All complaints should be responded to and the reason for the problems determined and addressed.

Each of these methods is described in more detail below.

Performance of a required operational function or service is considered acceptable when the number of discrepancies such as rush requests filled in more than 48 hours is below a predetermined proportion of transactions. Most levels of acceptance found through 100 percent inspection are stated in terms of percentages. The percentages should be computed periodically (usually monthly) by dividing the number of discrepancies by a lot size or sample frame (usually monthly or quarterly output). For required services inspected by random sampling, the number of faulty items or services which determine a lot rejection is determined by an acceptance level and the statistical quality control methods applied.

In many instances, the acceptance or rejection of performance will be determined by 100 % inspection made on a periodic basis (usually monthly) In order to assist 100% inspection to observe timelessness, it will be necessary to maintain records (logs) of transactions so that timeliness of events can be determined. In the example above, a log must be maintained for each order covering the date of request, date of order placement, date of return, date of delivery, and so on. The logs (maintained manually or on an automated system) could highlight activities that exceed performance standards of timeliness. In other instances, timeliness of activities, such as delivery of periodic reports, can be observed through review of each report and its delivery.

In order to assess timeliness, a set of guides are provided at the end of this chapter. These guides (Observation of Timeliness Guides Numbers 1 through 3) are based on transactions which require records (logs) under any circumstances and thus, records of timeliness (i.e., time at which events are performed) are merely additions to the existing logs. For example, a record is usually maintained when a request is made for an item (see Observation of Timeliness Guide No. 1). Examples of events which must be recorded for that item to ascertain timeliness are: dates of original request, when order is placed, claiming, receipt of item processed, check in circulated item, modify copy, or original cataloging. Obviously, these events involve several functions including acquisition and cataloging. In order to inspect timeliness standards for special cases, it is necessary to identify special classes of transactions. In the example above, this would include distinguishing between normal and rush orders; new serials or continued serials, and so on.

The surveillance records can be maintained in any one of several ways including logs or computer records. Such logs or records should have some mechanism(s) for highlighting events that fall below the acceptance standards. Otherwise, the logs or records must be perused monthly to identify instances where the standards are exceeded.

The second principal method of inspection is random sampling. In this case, a periodic (usually quarterly) lot of output is sampled and inspected. For example, the acceptance level or original cataloging is that no more than five percent of the items originally cataloged shall fail to conform to information center standards. A supervisor, or someone designated by the supervisor, should determine whether sample outputs conform to information center standards. For example, there might be 600 items originally cataloged annually at the information center standards. These are subdivided into quarterly output and randomly sampled using the following methods. There are about 150 items originally cataloged quarterly. These are the lots to be sampled. There is a standard statistical guide for determining sample size based on the lot size. This guide recommends a normal sample size of 20 for a lot size of 150 (see Table 6.1). The level of acceptance and rejection is given in Table 6.2. The acceptance levels in the table include 4.0 percent and 6.5 percent, but not 5 percent, thus 6.5 (higher) is used.

TABLE 6.1
SAMPLE SIZES TO USE AS A FUNCTION OF LOT SIZE AND PRECISION REQUIRED

Lot Size	Normal Sample Size
2 - 8	2
9 - 15	3
16 - 25	5
26 - 50	8
51 - 90	13
91 - 150	20
151 - 280	32
281 - 500	50
501 - 1,200	80
1 201 - 3,200	125
3,201 - 10,000	200
10,001 - 35,000	315
35,001 - 150,000	500
150,001 - 500,000	800
500,000 and over	1250

Source: A Guide for Writing and Administering Performance Statements of Work for Service Contracts, Supplement #2 to OMB Circular No. A-76

TABLE 6.2
MIL-STD 105D ACCEPTANCE, REJECTION LEVELS FOR NORMAL INSPECTION

Sample Size	Acceptable quality Levels* 4.0% Ac	4.0% Re	6.5% Ac.	6.5% Re	10.0% Ac	10.0% Re
8*	↓	↓	1	2	2	3
13	1	2	2	3	3	4
20	2	3	3	4	5	6

* Typical tables have sets of 15 sample sizes and 26 Acceptable Quality Level's

The table entry for 6.5 percent and sample size of 20 is 3 and 4, which means that nonconformance of 3 or fewer cataloged items from the sample of 20 from a quarterly lot of approximately 125 will constitute acceptance of that lot and nonconformance of 4 or more cataloged items from the sample of 20 means that the lot does not meet an acceptable level of performance. It is noted that the rejection level of 3 nonconformed items corresponds to 15 percent i.e., 3 divided by 20) which permits 10 percent (15 minus 5%) leeway due to sampling error. The items to be randomly sampled would be determined by the supervisor or other designated person.

There are basically two ways in which random samples should be selected. The first of these involves the use of random tables. A table of random numbers is given below. In the first sampling procedure, a lot from which the sample will be drawn is listed or ordered so that one can identify an item with a number (from 1 to the number of items in the lot). Then random numbers are chosen from the table and the numbers assigned to those designated in the lot. This represents the sample. The second method involves systematic random sampling. In this procedure, the lot size (i.e., number of items in the lot) is divided by the sample size to determine a sampling interval (e.g., every tenth or thirty-second record). Then the first sample item is chosen by choosing a random number from one to the number in the sample interval (e.g., 10 or 32) using the table of random numbers. The remaining sampled items are chosen systematically by counting the interval (10 or 32). Thus, if the sampling interval is 32 and the first random number is 24, the samples are 24, 56, 88, 120, 152, etc. Instructions on how to use the random table are given below.

The random numbers in the table are arranged in groups of five numbers (i.e., 58651, 25480, etc.). To use the table, begin by picking at random a group of numbers on any page of the table. Various patterns should be used alternately. For one sample one can use rows, for the next sample one can use columns, and for the third sample one can establish a diagonal pattern.

TABLE 6.3
EXAMPLE OF RANDOM NUMBER TABLE PAGE

Rows*	Columns* 1	2	3
1	58651	25480	46689
2	90578	71705	43472
3	31535	21726	32554
4	47490	16907	58179
5	48159	39410	05665

* Note that typical random tables have as many as 750 five digit sets of random numbers per page

The use of variety in the Random Number Table ensures that patterns that might be detected by staff do not occur. Besides starting at different random points and alternating the patterns for finding a string of random numbers, the user may at some point in time wish to use the first significant digits instead of the last. For instance, in the random number group 58651 the last three digits (i.e., 651) are used when looking for a random number with three digits, but there is no reason why one could not, for a period of time, use the first three digits (i.e., 586).

The person responsible for quality assurance should first select the areas and times for random sampling using the procedures in the sampling guides and program these inspections on the schedule. When the sampling procedure does not allow for specific selection of inspection items during the preceding quarter, it would be necessary to show on the schedule the date and time the sample selection will be accomplished and when the inspections will be conducted. Then one should program into the schedule the periodic checklist items to be reviewed during the period. This schedule should show what the responsible person is monitoring each day.

Tally checklists should be prepared for each sampling guide and used to record information on observations and defects.

Each observation in the sampling should be recorded on the tally checklists. These documents then become formal record for later reference. The tally of observations and defects at the end of the month would be compared to the acceptable number of defects appearing in the appropriate sampling guide. Any errors detected during the course of the surveillance, even if not of sufficient degree to render the service unsatisfactory in terms of the acceptance level parameters, would require corrective action by the supervisor, if possible.

In some instances, inspection requires visual observation of activities or events. In order to achieve such inspection, random spot checks of the operation could be made by a supervisor or manager. Such spot checks should be made on a weekly and monthly basis depending on the observation made. Note that the process of spot checks will have the effect of the staff knowing certain activities have to be done and on time.

In many instances, it is necessary to inspect a report or output of an activity to determine whether it is provided within quality standards. Examples of functions and activities for these are listed below.

1) Monthly review of records to see that titles and items requested are the same as titles received unless not in print.
2) Monthly review of records to see that review for subscription claiming is done twice per year.
3) Special reports and other materials meet standards set for content and format and time specified.
4) Observe repairs to see that repair process meets specifications for all items involved.
5) Observe inspection reports to see that security inspection includes all structural and environmental features, the log meets specifications and performance of safety officers meets requirements.
6) Review and compare all items chosen and deleted by selection staff to see that they are appropriate.
7) Monthly review of records to determine if journal continuity is maintained.
8) Meet with staff to determine that they maintain currency of knowledge through specified means and events and that this is reported in monthly reports.
9) Review records to determine that interlibrary borrowing does not involve more than 5 requests for a title.
10) Monthly review of records to determine that incoming and outgoing mail is delivered correctly and messenger assignments are accomplished successfully.

OBSERVATION OF TIMELINESS GUIDE NO. 1

1. **Function(s)**

   Acquire Materials for the Information Center.
   Catalog and Classify Materials for the Information Center.

2. **Transactions**

   A transaction is acquisition of specific items (i.e., monographs, serials, etc.). Events associated with each transaction are traced from request through technical processing.

3. **Events**

   Events in which time should be recorded include:
   - Request
   - Order placed
   - Receipt processed
   - In-house routing of serial issues
   - Claiming of 1st order items
   - Claiming of serial issues
   - Modify OCLC copy
   - Original cataloging

4. **Special Classifications (Attributes)**

   Materials need to be identified in the following ways:
   - Normal orders
   - Rush orders
   - New serials
   - Continued serials
   - Continued serials (without lapse)

5. **Surveillance Method**

   The surveillance method involves inspection of all acquired items, the events listed above and when they took place.

OBSERVATION OF TIMELINESS GUIDE NO. 2

1. **Function(s)**

   Provide Information, Reference, and Research Assistance Services

2. **Transactions**

   Transactions are reference questions or full searches initiated by a user

3. **Events**

   Request
   Interview with user
   Searching, packaging, and dispatch

4. **Special Classifications (Attributes)**

   Rush searches
   Walk-in requests
   Telephone requests

5. **Surveillance Method**

   Review records monthly to see that events are performed within standard times.

OBSERVATION OF TIMELINESS GUIDE NO. 3

1. **Function(s)**

   Provide Circulation Service for and Physical Access to Information Center Materials

2. **Transactions**

   Transactions are circulated items; interlibrary borrowing requests; interlibrary loan requests; and access through document delivery services.

3. **Events**

Item need determined
Response
Follow-up overdues
ILB or document delivery vendor request
Repeat ILB or document delivery vendor request
ILB or document delivery vendor item sent to user
ILL request
ILL discharge
Forms filed
Materials shelved

4. **Special Classifications (Attributes)**

Rush requests

5. **Surveillance Method**

Review request forms to see that events are performed within standard times.

RANDOM SAMPLING GUIDE NO. 1

1. **Function(s)**

Catalog and Classify Materials

2. **Unit of Observation**

Items originally cataloged

3. **Acceptable Quality Level(s)**

Over 5.0 percent of items are not cataloged to information center conformance standards

4. **Lot Size for Sampling**

All quarterly items cataloged

5. **Sampling Size**

6. **Sampling Procedures**

Divide the lot size by 20 which determines the sampling intervals (e.g , every 6th record). Then choose the first sampled item by choosing a random number from one to the number in the sample internal (i.e., 6). The remaining sampled items will be chosen systemically by counting the interval (6).

7. **Inspection Procedures**

The items cataloged will be inspected to ascertain that original cataloging conforms to standards.

8. **Performance Criteria**

Performance is satisfactory when three or fewer items are not originally cataloged to conformance standards and performance is unsatisfactory if four or more items are not cataloged to conformance standards.

RANDOM SAMPLING GUIDE NO. 2

1. **Function(s)**

Provide Information, Reference, and Research Assistance services.

2. **Unit of Observation**

(a) A completed online search
(b) A completed manual search

3. **Acceptable Quantity Level(s)**

Over 6.5 percent of database searched online not relevant to question.

4. **Lot Size of Sampling**

All on line searches performed in a quarter.

5. **Sampling Size**

50 online searches quarterly.

6. **Sampling Procedures**

A systematic random sampling of online searches where the sampling starting point is varied weekly

7. **Inspection Procedures**

Each week the online searches are identified and the search procedures and output are reviewed from the search records.

8. **Performance Criteria**

Performance is satisfactory if seven or fewer databases are not relevant or do not show relevant items and unsatisfactory performance is when eight or more searches do not meet these standards.

Part 3

Evaluation of Information Center Effectiveness

Chapter 7

Statistical Survey Methods for Evaluating Information Center Effectiveness

7.1 Background

In this chapter we discuss statistical survey methods used for evaluating information center effectiveness. In particular, these statistical surveys involve the middle perspective on the framework given in Figure 4 in Chapter 2. In these surveys are such user-related measures as user input costs (E on the figure), output quantities and attributes (F), and activities and resources used in work (D). More specifically, these surveys focus on information resources used (D) and the interface (f) with information center output quality, timeliness, accessibility and availability. In other chapters of this Part on Evaluation of Information Center Effectiveness, we give specific examples of survey methods applied to evaluating the use and usefulness of information centers (Chapter 8), and use and usefulness of specific services (Chapter 9), as well as higher order effects of information use and the contributions that information centers make to information use (Chapter 10). In this chapter we focus on some fundamentals of statistical survey methods that can be used for any of the statistical surveys applied in evaluating information centers.

There are many instances in evaluation in which data about information center services need to be collected from individuals. Such data may provide information about who uses and does not use center services and, more importantly, why services are not used. Such information can also be used to establish the use, usefulness and value of information services on users' work. Thus, one can link the performance of services in terms of their quality, timeliness, availability, accessibility, etc. to their purpose of use, and how their use affects user's work. A substantial number of evaluation studies involve users of information services. In this chapter we emphasize examples of survey methods that might be employed in such evaluation studies. Again, we focus largely on survey examples that fit the overall evaluation framework discussed in Part 1, Chapter 2 of this Manual. Note that the methods described here apply equally well to other survey measures and evaluation studies.

User studies cited in the literature, for the most part, investigate users of specific information services, products or systems. The survey methods described in subsequent chapters provide a comprehensive set of surveys that, together, provide a "complete" picture of the entire range of services provided by information centers. Furthermore, the surveys carefully tie operational performance (i.e., relationships of a center's input costs of resources and their attributes and output quantities and attributes) to service effectiveness. The focus of evaluation surveys is on users and prospective users. We try to obtain data that indicate why services are and are not used, and what the consequences of use and non-use are to the information center and the center's and/or user's parent organization.

The investment an information center makes in both time and staff resources to conduct evaluation surveys will vary with each center and the services being evaluated. In every case, however, management should ask what results will be achieved from the survey before it is designed and implemented. Evaluation surveys, in themselves, will not result in change. The survey results are merely instruments for change, to be used with other sources of information and knowledge to be applied with good judgement. We strongly believe that evaluation surveys should be done only if decisions are going to be based on them. We also recommend that such decisions should be made within the framework of the information center's mission, goals and objectives (see Chapter 1). With measurable center objectives, one can derive meaningful evaluation goals and measurable center objectives. For example, a center objective for a particular service might be to provide X number of transactions, of which 80 percent are to be rated for quality and timeliness as satisfactory or very satisfactory by users. The evaluation survey can then be designed to measure the number of transactions and ratings of satisfaction with quality and timeliness. In addition, the survey can be designed to identify factors that affect the number of transactions and user satisfaction, so that decisions can be made to help increase the number of transactions or satisfaction ratings, if they are found to be too low. For example, satisfaction with timeliness of service provision might be that some transactions require fast response and others don't. Thus, a decision can be made to handle "rush" requests differently from others. Or it might be that the distance of some users from the information center requires different response mechanisms. Number of transactions can depend on many factors, such as inherent need for the service, competition from other sources, awareness of the service and service performance. Thus, data can be gathered about these factors to aid in decisions relating to the number of transactions stated in the measurable objective.

Evaluation surveys provide merely a snapshot in time. To be an effective management tool, one must consider the possibility of making surveys part of an ongoing process to provide relevant management information. Surveys do not normally need to be conducted weekly or monthly. However, one should adapt procedures and a system of measures about users that will yield data at appropriate intervals of time. For example, if a center objective is to increase levels of transactions (from X number to Y number) and satisfaction ratings (from 60% satisfied to 80% satisfied) over three years, one must be able to measure progress each year and to determine the effects of decisions (e.g., to handle "rush" requests differently, to increase awareness of the service, etc.).

Finally, by knowing and understanding operational performance (i.e., cost per transaction at various levels of quality and timeliness), center management can estimate what it would cost to achieve the center objective of

increased transactions and satisfaction ratings. Furthermore, one can speculate with some degree of confidence as to what effect achieving the objective will have on users' work. This presents a much stronger case to funders for increasing budgets. Thus, evaluation surveys and operational evaluation together can facilitate planning, management and administration, which can lead to better service. This requires obtaining reliable and useful data and information from evaluation surveys. Below we describe survey methods that should achieve this objective.

7.2 Components of Survey Design and Application

There are eight basic components of survey design and application as follows:

- Overall evaluation design
- Data collection methods
- Sample design
- Questionnaire design
- Data processing
- Data analysis
- Statistical analysis
- Presentation.

Surveys are like a chain in which each process in a survey, like links in a chain, are equally important. If one process is done improperly, the entire survey results can be ruined or invalid results obtained, regardless of how well all the other processes are done. The eight components above are discussed in this and subsequent chapters.

7.3 Overall Evaluation Design

The methods employed in surveys depend on the overall evaluation design which is dependent on:

- the objectives of the evaluation and the decisions that will be made as a result of the evaluation;
- who or what will be affected by the decisions (i.e., center staff, management, users, funders, etc.);
- the overall environment in which the information center operates including such factors as a single versus multiple sites served by the center, number in the population served, whether or not the population served is in (i.e, employed by) the same organization as the center; and
- the current knowledge concerning center users and prospective users.

These issues dictate to a large degree the survey methods used for data collection, sample design, questionnaire design, and the other components listed above. We emphasize that there is also an interdependence among the components. For example, data collection methods (e.g., self-administered questionnaire, telephone interview or personal interview) will dictate, in part, the questionnaire design. How the questionnaire is designed will affect data processing, and so on.

7.4 Survey Data Collection Methods

Surveys obviously require input from respondents drawn from the population being surveyed. Surveys should be thought of as part of a communication process, where the researcher (evaluator) is communicating with the respondent (data provider). This communication is a two-way process in that the wording of questions is the researcher's method of communicating and responses to the questions form the respondents' communication. Sometimes we ask respondents if they would like to see the survey results. The communication process can be characterized by the degree of interaction between the respondent and the evaluator. The utility of various methods depends on such factors as required accuracy of communication, time and cost constraints. There are six basic survey data collection methods that might be used for evaluation purposes[2,4].

- *Self-administered questionnaires.* This is probably the most commonly used data collection method. The method involves (1) sending the questionnaire to respondents through the mail or the organization's distribution or (2) handing the questionnaire to an information center user, who is asked to fill it out and return it to the center or evaluator. This method is inexpensive and has the advantage of letting respondents fill out the questionnaires at their own pace and to think about their responses more thoroughly. However, this method has the distinct disadvantage of potential low response rates. Typical mailed questionnaires, for example, often result in less than 20 percent responses and questionnaires handed out in information centers often result in less than one-third responses. Those who voluntarily complete a questionnaire may be different from whose who do not (e.g., they may be frequent users, less busy, better educated, etc.). Generally, one should aim for more than 50 percent response rates. From a cost standpoint, it is far better to have a smaller initial sample, and achieve higher response rates (through telephone follow-ups to non-respondents or some other means of follow-up) than to have a large sample with low response rates. If all the information that is collected is for measures and derived indicators, a combination of telephone interviews and self-administered questionnaires will suffice. For example, when visitors leave the center, they can be asked to fill out questionnaires at that time (with tables or desks set aside to do this) or asked to fill them out at their offices and return them (on subsequent visits or by mail). The sampled individual can be asked for name and telephone number to permit telephone follow-up (to clarify responses if necessary) or to obtain the information over the telephone if the person has not responded. If the information center is part of the respondents' parent organization, one can expect higher response rates than if it is not. We expect about 40—50 percent initial response rates for professionals employed by the center's parent organization and sufficient responses are achieved by letter follow-up and then telephone follow-up, if necessary, to prompt response or to actually collect data. Only about one-fifth of the surveys we have performed in this environment have required telephone follow-up. Another aspect of self-administered questionnaires is that the questionnaire must be carefully structured and worded with sufficient instructions and definitions of terms.
- *Observation of users in the information center.* Another method is to merely observe users in the center to determine what services and resources they use. If the observations can be made unobtrusively, one can measure extent of use of the services and resources. On

the other hand, the method is very limited in the number of measures that can be obtained and must be accompanied by collecting data (from the same persons) on frequency of visits and use, satisfaction, and so on.

- *Telephone interviews.* The telephone interview is an excellent method for collecting survey data. This method should achieve a higher response rate than self-administered questionnaires, but less than personal interviews (see below). The time taken to complete the survey can also be lower than for self-administered questionnaires so this method is often used if the evaluation has to be completed in a short timeframe. The telephone interview questionnaire can be less structured than the self-administered questionnaire and communication is enhanced by letting respondents ask questions and interviewers clarify responses. There are some drawbacks to telephone interviews:
  - They are more expensive than self-administered questionnaires, but less expensive than personal interviews.
  - Interviewers must be trained.
  - They require staff, telephones and facilities to do the interviewing.
  - There must be a current and complete telephone directory, although this should not be a problem when respondents are employed in the center's parent organization.
- *Personal interviews.* Personal interviews are conducted by having interviewers ask questions from a survey instrument or interview guide. This method can be used only when it is possible to communicate with respondents directly such as in the information center or at the respondents' place of work. The interviewers normally ask specific questions and record the answers. They can also clarify the intent or meaning of questions, if asked. Most of the data obtained for effectiveness measures can be precoded and, therefore, recording bias can be kept to a minimum. Personal interviews have the advantage of permitting complex questions and lengthy interviews. However, neither of these two conditions are necessary for data collection for effectiveness measures. On the other hand, the cost of personal interviews is high because interviewers should be trained and, if the interviews are conducted in workplaces, there are substantial additional costs associated with setting up the interviews, travelling to and from the locations of the interviews, and calls back when respondents are not available or do not show up. This survey method probably should not be used unless:
  - the effectiveness measures data are being collected as part of a larger data collection effort, or
  - the data collection is done in the information center. (This excludes general population surveys.) Center staff members can conduct interviews for general user surveys, visitor surveys, or specific service surveys. The interviewers should not be those who are associated with any specific service for which data are being collected (e.g., reported response times, satisfaction with quality, timeliness, availability, access, etc., for specific services).
- *In-depth interviews.* This method is used for very specific types of evaluation; for example, when a very new or unique service is being contemplated, or for a pretest of the survey. In-depth interviews require a significant degree of interaction in order to probe and gain an in-depth understanding of important issues. The interviewer may actually follow a service user through the process of interacting with the information center and its environment. When used for a pretest, an in-depth interview can establish acceptable terminology that can be used in a survey questionnaire. For example, one can learn what to call an informal collection of documents that is shared by a group of professionals (examples we have found acceptable in different environments are "shared office collections," "local library," or "unit library," etc.) or what professionals call regularly routed journals ("routed journals," "circulated journals," etc.). One can also probe to gain a better understanding of information-related behavior, general awareness of information services, use of alternative sources (to the center) and so on. About six to 12 such interviews can be enormously helpful. They normally take 30 to 45 minutes each. This method is usually loosely structured, with only a portion of information requiring formal questions. The questions often lead to formulation of other issues and questions. The interviewer must be very communicative and be able to identify when further probing is necessary. The in-depth interview is expensive on a per interview basis.
- *Focus group interviews.* This method involves gathering a small group(s) of users or potential users (eight to ten is common) together in an informal atmosphere to get them to discuss issues of interest. This method capitalizes on interactions among the participants with a moderate amount of stimulus from a moderator. The moderator guides discussions and listens more than talks. The advantage of this method is that interaction among participants often creates a whole greater than the sum of the individual interaction. On the other hand, the process is expensive and yields information from a relatively small group.

The in-depth interviews and focus group interviews are often used to enhance the communication performed on a broad scale and to formulate hypotheses that can be tested through a statistical survey.

7.5 Statistical Sample Design

Statistical sampling methods are used for three purposes First, they provide a formal mechanism for making sure that the most precise estimate possible are obtained for a given budget. Second, they help ensure that correct (non-biased or accurate) estimates are obtained. Finally, they provide a formal means for estimating the precision of the observations made. Inherent in the statistical methods are procedures for determining what sample sizes are necessary for achieving certain levels of statistical precision. This section discusses four important aspects of statistical sample design and their effect on the reliability of estimates based on the sample survey. The three principal kinds of estimates made from evaluation surveys are:

- *Population totals* including the number of persons who use an information center or its services, number of uses of the services, amount of reading of journal articles provided by information centers, total amount of time users spend in using the services, etc
- *Population averages* including the average number of visits to information centers per year per user, average time spent reading articles per reading, average time spent reading articles per reader, average rating of satisfaction with a service, etc.
- *Population proportions* including the proportion of the intended target population who visit or use the information center, proportion of the population who are aware of a service, proportion of uses of a service in which the user is satisfied or very satisfied with speed of response, etc.

In addition, survey observations can and should be made so that one can relate one measure to another. For example, one may wish to relate distance from the center to the amount of use made of center services, or levels of satisfaction with amount of use (i.e., to show that amount of use decreases as distance increases or satisfaction decreases). We will demonstrate that one can also obtain data for sophisticated modeling that illustrates the relative contribution such factors make to amount of use (see Chapter 11)

- *Statistical sampling methods.* The sampling frame can be arranged in ways that can provide specific information or improve survey precision of estimates and/or cost effectiveness of the survey data collection. The design also helps ensure that correct (unbiased or accurate) estimates are obtained. They also provide a formal means for estimating precision of estimates. Examples of statistical sampling methods include simple random sampling, systematic sampling with a random start, stratified random sampling, multistage sampling, cluster sampling and ratio estimation.
- *Sampling population and sampling frame.* The sampling population is the universe of people, objects or events which one can describe or measure. The population may be all professionals employed by the center's parent organization, all scientists in the country, the items shelved in the center, or all of the uses on an online catalog. The sampling frame is a physical list of units that make up the population or procedures that can account for all the sampling units without the physical effort of actually listing them.
- *Sample size.* The number of persons, objects or events chosen for the initial sample. The ending sample size is the number of units that respond to the survey or that are observed. The size of the sample (i.e., ending sample) partially determines the precision of survey estimates.
- *Sample selection.* The method used for choosing sampling units after a statistical sampling method is established, and initial and ending sample sizes have been determined.

Each of these aspects of sample designs is discussed further below.

Statistical Sampling Methods

The most basic, straight-forward sampling design is *simple random sampling* although it is infrequently employed for several reasons that are discussed below. As the name implies, the design is based on random sampling from a sampling frame of individuals, events or objects. The basis of the random sample is to be able to assign a known probability of selection to each item or unit in the sample frame. A simple random sample implies that each unit has an equal chance of selection. For this to be true, it is necessary to construct a sampling frame and establish a selection procedure.

The first step is to define the population to be sampled. A population might be all professionals in an organization, all scientists who belong to a professional society, all the online users, all online uses, or items retrieved from online searches. It is not enough to define the population for sampling purposes; one must also identify units within the population so that they can have a known chance to be chosen in a sample. The identity of units, which are frequently listed, is called a sample frame; and the items on the list are called sample units. The sample selection procedure involves the manner in which individual sample units are chosen. Some statisticians insist that the sample be chosen in a completely random manner, using tables of random numbers. However, a perfectly valid method, which is far more practical, is to employ a *systematic sample with a random start.* In this procedure one simply takes the desired sample size and divides that number into the number of sample units in the sample frame and then samples through the list using that interval (called sampling interval). Suppose we have a list (or directory) of 2,000 professionals in an organization. If we wish to interview 200 of the professionals, we would divide 2,000 by 200 to establish a sampling interval of 10. First draw a random number between 1 and 10 to use as a starting point in the sample — say 7. With a sampling interval of 10, the sampled units would be the seventh and every tenth name beyond that (i.e., 17, 27, 37, . . .). The only caveat about using a systematic sample with random start is that there can be periodicity in a listing which can bias the sample selection. For example, suppose the sample frame is days over time. A sample interval of seven would mean that a specific day (such as Tuesday) would always be chosen; and there could be differences among days that would not be represented in the sample procedure described.

As mentioned earlier, there are statistical sampling methods that are designed to provide better results than the simple random sample. One of these designs, *stratified random sampling,* takes advantage of information known about the sampling units in order to provide more precise estimates. For example, if one knows that some professionals are more likely to be center or service users (e.g., scientists and lawyers versus financial and operational professionals), the designer can apply this information to improve the sample design. That is the sample frame can be subdivided into groups of professionals of like work roles (e.g., R&D, operational, legal work, etc.). If the assumption concerning the relation of work role and center or service use is correct, the precision of estimates should be less than the precision of the estimates found from a simple random sample (or systematic random sample). This means that the confidence interval of an estimate from a stratified random sample is narrower than estimates from a simple random sample, if the sample size is the same for both designs. Conversely, one can achieve the same level of precision with a smaller sample using a stratified random sample than from using a simple random sample. The reason that the estimated precision of a

stratified random sample is less than one estimated for a simple random sample is that the standard error (i.e., measure of precision) estimate is based on the variability within strata, which can be substantially less than the variability across the entire population.

Three criteria should be kept in mind for allocating the sample size to the strata (e.g. R&D, operational, legal professionals, etc.). In a given stratum it is usually best to take a larger sample if any of the following conditions is true:

1. The stratum total population is larger than the others.
2. The stratum is more variable (i.e., the range of measures in the stratum is greater)
3. The sampling is less expensive to conduct in the stratum.

In the absence of appropriate information about the strata, one will not go too far wrong by employing the same sample fraction in each stratum.

There are exceptions to the rule above For example, assume that an independent information center (e g, clearinghouse or national library) is surveying libraries to determine extent of use of certain products or services. Here the stratification factor might be size of the library. In this case, it is probably better to sample more heavily in the stratum with larger libraries (i.e., it is usually best to give the larger units a greater chance of being chosen in the sample) For example, one would sum the sizes of libraries in the large, medium, and small strata as follows:

Stratum	No. of Libraries in Stratum	Average Size (in thousands of holdings)	Sum of Sizes of Libraries (000)	Sample Size
Large libraries	500	30	15,000	97
Medium libraries	750	15	11,250	72
Small libraries	1,250	10	12,500	81
Total	2,500		38,750	250

Thus, large libraries would be given a higher probability of being chosen in the sample If libraries had been chosen strictly proportionately, there would be 63 large, 94 medium, and 156 small libraries. Finally, note that if the purpose of stratifying is to make estimates about each stratum or to compare estimates among strata, it is best to make the sample sizes about equal among the strata (i.e, in the example above the sample would be 84 large, 83 medium, and 83 small libraries).

In making population estimates from stratified random samples it is important to take into account the disproportionate sampling among strata. Equations for estimating totals, means, and proportions are discussed in Chapter 10.

Another statistical sample design involves the situation in which the sample units of interest are part of a larger unit. For the example of the independent information center above, suppose that the unit of interest is online search users. Here one may want to determine time spent searching, satisfaction with search results, or other measures. The population of all users is difficult to identify, but libraries that provide online search services may be known. The sampling method then is to sample libraries (or information centers) and subsample their online users. If the number of users or online searches is large, a subsample of them would be necessary. This procedure is called *two-stage sampling:* the primary sampling units in the example are libraries, and the online searches by users are the secondary sampling units Sometimes the primary units are referred to as clusters if the number of secondary units is not identified or known before the sample is drawn.

Usually, to keep costs down, the number of primary sample units is reduced and the number of secondary sample units is increased. The question of how the samples are allocated among primary and secondary sampling units depends on the variability within clusters. At one extreme, if all the secondary sampling units were exactly the same (e.g., if libraries had rules that online searches could be for a given length of time), then it would be necessary to choose only one secondary sampling unit (e.g., one search per library). The sample size would be the number of primary sampling units chosen. At the other extreme is the case in which every cluster is like every other cluster (e.g , the average time spent searching and the variability of time spent searching is the same for all libraries) In this instance one would need to sample only one or a few primary sample units and subsample heavily in that unit(s). The sample size would be the number of secondary sampling units chosen. Usually the cost is less for fewer primary units sampled; therefore, a balance must be achieved between cost and precision of estimates. Generally, if information is available, it is best to choose the primary sampling units on the basis of size and choose the number of secondary units in equal proportion to size. That is, once a primary sample unit is chosen, a sample frame is constructed for the secondary sampling units and a random sample is chosen with a predetermined sample fraction (say, every twentieth unit). This sample fraction will be the same for sampling within every primary sampling unit.

Forming the sampling frame for secondary units can sometimes be difficult. In the online search example, there may be records of the searches performed over the past six months or year. In this case, the search time might also be recorded or the user identified, in which case defining a sample frame is not a problem. However, if the issue is to establish users' attitudes toward online search services, it is necessary to form a unique list of users, with recognition that many users may conduct several searches (or ask for several searches). An even greater difficulty occurs when information is needed from potential users as well as users. Here, potential users might be selected from directories of professionals, faculty lists, enrollment lists, or library patrons lists. A combination of stratified random sampling and cluster sampling is frequently used; that is, clusters are sampled within strata.

There can be any number of stages in cluster sampling. For the example above, one may wish to characterize bibliographic items found in public libraries, one might sample libraries as a first stage, bibliographic publications as a second stage, monthly issues as a third stage, and items within an issue as a fourth stage. It is usually best to give the larger units a greater chance of being chosen in the sample. In fact, a common procedure is to sample with probability in proportion to size (pps) This is done by listing the sample units within each stratum in order of size and selecting the

sample using a systematic selection with random start. For example, assume that the stratification factor is the number of persons served (e.g., faculty and enrollment in colleges and universities). One would list units in order by their size and the cumulative range of sizes as follows:

Sample Unit	Size	Cumulative Size Range
Library 1	50,000	0 - 50,000
Library 2	25,000	50,001 - 75,000
Library 3	20,000	75,001 - 95,000
Library 4	15,000	95,001 - 110,000
Library 5	10,000	110,000 - 120,000

The sample would be chosen by systematic sampling, using the size information. The total would be the total cumulative size (120,000 in the table above), and this number would be divided by the desired sample size (say, 3 libraries) to determine the sampling interval (i.e., 40,000). The first number would be chosen randomly between 1 and 40,000 and every 40,000th number chosen beyond that. If the random start was 18,542, the subsequent numbers would be 58,542 and 98,542. This means that the sample of three would be Library 1, Library 2, and Library 4, since their respective cumulative size ranges include the randomly selected numbers.

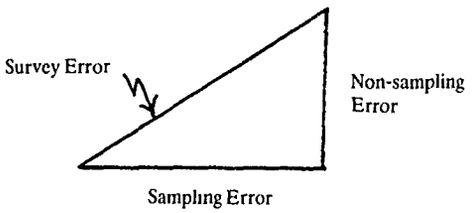
Another statistical method that has proven extremely useful in improving the precision of estimates is *ratio estimation*. This method employs an auxiliary variable about which we have information in order to calibrate estimates. In this method it is assumed that the auxiliary variable is highly correlated to the variable of interest. For example, we indicated earlier that the amount of online searching performed in a library (X) is probably highly correlated to the size of a library, say holdings (y). We also probably know the total number of holdings in a population of libraries (e.g., academic libraries) since directory listings usually indicate library holdings. Ratio estimation is like using a stratified random sample where the stratification factor is continuous rather than discrete (e.g., large, medium, and small libraries). In effect the variate used in the ratio estimation merely serves as a powerful calibration.

7.6 Survey Reliability

One cannot expect estimates of proportions, averages, totals, etc. taken from a survey to be exactly the same as the true population value. The difference between survey estimates and true population values is attributable to survey errors. There are two types of error that can occur in surveys.

- *Sampling error:* The difference between an estimate (e.g., proportion, average, total) and the true population value which is due to the fact that only a sample of values is observed. If the survey is a census (i.e., every unit in a population is observed) there would be no sampling error. Sampling error can be estimated from a random sample and is called standard error. Precision of survey sample estimates is a function of sampling error.
- *Nonsampling error:* This error, sometimes called bias, is that part of the difference between an estimate and the true population value is due to mistakes in survey processes or impreciseness of survey communication. Nonsampling error is rarely attempted to be measured because of the extreme difficulty of doing so. Accuracy of survey sample estimates is a function of nonsampling error.

The total difference between survey estimates and true population values is due to a combination of these two types of errors in the following way:



That is, the total survey error is like the hypotenuse of a right triangle; where the legs of the right triangle are sampling error (x) and non-sampling error (y). Thus, total survey error is:

$$\sqrt{x^2 + y^2}$$

Sampling Errors

Precision of estimates from samples is measured by standard errors of estimates. Equations of standard error include the deviation of responses from the true value and sample size. Examples of equations of standard error (SE) are as follows:

Proportion. The equation for the standard error of a proportion SE(p) is:

$$SE(p) = \sqrt{\frac{pq}{n}}$$

Where: p is the estimate of the proportion of interest
q is the complement of p (i.e., 1−p)
n is the sample size.

Referring to Table 71, we find that the users rated satisfaction with relevance of search output as follows:

TABLE 7.1
SATISFACTION RATINGS OF 50 SURVEY RESPONDENTS

Sample	Satisfaction Rating Score	Sample	Satisfaction Rating Score
1	3	26	3
2	5	27	5
3	1	28	3
4	4	29	4
5	4	30	5
6	5	31	4
7	5	32	5
8	2	33	4
9	1	34	2
10	4	35	5
11	5	36	4
12	4	37	2
13	3	38	3
14	2	39	4
15	2	40	4
16	3	41	3
17	5	42	4
18	2	43	5
19	4	44	5
20	3	45	2
21	4	46	1
22	5	47	3
23	4	48	5
24	5	49	3
25	2	50	4

Rating Scores: 1 - Very Dissatisfied, 2 - Dissatisfied, 3 - Neither Satisfied nor Dissatisfied, 4 - Satisfied, 5 - Very Satisfied.

Satisfaction Rating	Rating Score	No. of Users	Proportion of Users
Very Dissatisfied	1	3	0.06
Dissatisfied	2	8	0.16
Neither Satisfied Nor Dissatisfied	3	11	0.22
Satisfied	4	14	0.28
Very Satisfied	5	14	0.28
Total		50	1.00

Thus, 0.56 (56%) of the users rated searches as satisfied or very satisfied (0.28 + 0.28). Thus, the standard error of this estimate is as follows:

$$SE(p) = \sqrt{\frac{(0.56)(0.44)}{50}}$$

$$= 0.07 \ (7.0\%)$$

The confidence level for this estimated proportion is:

56.0% ± 13.8% at 95% level of confidence

Average. The equation for the standard error of an average SE ($\bar{x}$) is:

$$SE(x) = \sqrt{\frac{\Sigma (x_i - x)^2}{n(n-1)}}$$

Where: x_i is one of the observations
$\bar{x}$ is the estimated average
n is the sample size
Σ means that $(x_i - \bar{x})^2$ is added up over all x_i

Referring again to Table 7.1, the average satisfaction rating is found to be 3.56 (178 divided by 50). The estimated standard error of this average is found as follows:

$\Sigma(x_i - \bar{x})^2 = (3-3.56)^2 + (5-3.56)^2 + \ldots$ etc.

Since observations (x) have only five values (1, 2, 3, 4, 5) the summing is simplified as follows:

$\Sigma(x_i - \bar{x})^2 = (1-3.56)^2 \times 3 + (2-3.56)^2 \times 8 + (3-3.56)^2 \times 11 + (4-3.56)^2 \times 14 + (5-3.56)^2 \times 14 + (4-3.56)^2 \times 14 + (5-3.56)^2 \times 14$
$= 19,6608 + 19.4688 + 3.4496 + 2.7104 + 29\ 0304$
$= 74.32$

$$SE(x) = \sqrt{\frac{74.32}{50(49)}} = 0.17$$

The confidence interval for this estimated average is:

3.56 ± 0.33 at 95% level of confidence

Total. The equation for the standard error of a total SE(X) is:

$$SE(X) = \sqrt{\frac{N^2 \Sigma (x_i - x)^2}{n(n-1)}}$$

Where: x_i is one of the observations
$\bar{x}$ is the estimated average
n is the sample size
N is the population size
Σ means that $(x_i - \bar{x})^2$ is added up over all x_i

Table 7.2 gives values of search times. The estimated average search time is 71.9 minutes. If we assume that there are 10,000 total searches a year, our estimate of total search time is 719,000 minutes or 11,990 hours. The estimated standard error of total search time is calculated as follows:

$(x_i - x)^2 = 41,968.82$

$$SE(X) = \sqrt{\frac{(10,000)^2 (41,968.82)}{(50)(49)}}$$

$= 41,388$ minutes or 690 hours

The confidence interval for this estimated total is:

11,990 hours ± 1,350 hours at 95% level of confidence

A further discussion is given below concerning the meaning of confidence intervals.

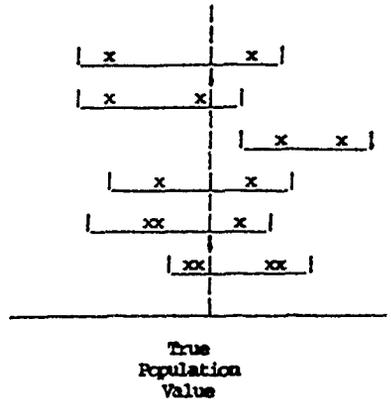
Confidence Intervals of Estimates from Samples

Standard errors of estimates can be used to calculate confidence intervals of estimates. A common way of expressing confidence intervals is:

The proportion of users satisfied and very satisfied with relevance of search output is:

56.0% ± 6.1% at 0.95 level of confidence
or
(49.9%; 62.1%) at 0.95 level of confidence

This means that the confidence interval has a 95 percent chance of containing the true population value of the proportion of users who are satisfied and very satisfied Confidence intervals are in fact estimates from a sample, just as a proportion, average or total is an estimate. Thus, if another sample is taken one would arrive at another estimate to the proportion above, as well as the width of the confidence interval. In fact, if one repeated the sample many times, we would find that 95 percent of them would include the true population value. This is shown by the figure below:



As shown, most of the confidence intervals contain the true value which is represented by the vertical line. The estimated value (i.e., proportion, average, total, etc.) is sometimes to the left of the true value line and sometimes to the right and, therefore, the entire interval moves accordingly. Furthermore, the width of the confidence interval changes for each sample.

TABLE 7.2
VALUES OF SEARCH TIMES FOR 50 SURVEY RESPONDENTS

Sample	Time (Minutes)	Sample	Time (Minutes)
1	42	26	79
2	108	27	58
3	32	28	46
4	21	29	99
5	84	30	56
6	61	31	119
7	110	32	94
8	52	33	34
9	103	34	79
10	72	35	96
11	31	36	59
12	89	37	39
13	63	38	114
14	112	39	74
15	51	40	97
16	68	41	39
17	84	42	107
18	63	43	79
19	33	44	58
20	85	45	97
21	92	46	120
22	115	47	37
23	48	48	118
24	97	49	98
25	46	50	47

The width of the confidence interval is affected by two factors:

- the desired level of confidence
- the estimated standard error (SE)

The confidence interval is computed from the following simple equation:

Confidence interval is the estimate plus or minus the standard error times a factor which represents the desired confidence level.
or
for example: $P \pm SE \times t$

The value of t is determined by the desired level of confidence. For example:

t = 1.00 for 68 percent level of confidence
t = 1.64 for 90 percent level of confidence
t = 1.96 for 95 percent level of confidence
t = 2.57 for 99 percent level of confidence

Going from a 68 percent to a 95 percent level of confidence, one would merely double the width of the confidence interval (i.e., 1 times standard error to 1.96 times standard error). This is shown in the figure above by x and o on the confidence interval:

68% level of confidence

o x x o
└──────────┘

95% level of confidence

Thus, at 68 percent level of confidence (shown by x_s) the width of the confidence interval is narrower than the 95 percent level of confidence (shown by O_s) and only 68 percent of the confidence intervals would contain the true values.

The size of estimate standard error, in turn, is affected by four factors. Assume example confidence intervals for an estimated proportion of 0.50 (or 50%) with a simple random sample size of 200 might be displayed as:

50% + 3.5% at 68% level of confidence

(1) *Sample size.* For the example, the estimates above are estimated from a sample size of 200 observations. If one doubled the sample size to 400, the confidence interval would decrease from 3.5 percent to 2.5 percent at 68 percent level of confidence. If the sample were reduced to 100, the confidence interval would increase from 3.5 percent to 5.0 percent at 68 percent level of confidence

(2) *Sample size relative to population size.* If the sample size were in fact the entire population, the confidence interval would be zero. The example above assumes that the sample size is very small compared with the population size. Since the sample size of some types of users may be reasonably high compared with the population of users, there is some gain in reduced confidence intervals. For the example above, if one assumes that a sample of 100 users of a service is from a population of 300 users the confidence interval would fall from 5.0 percent to 4.1 percent.

(3) *Inherent variability of observations.* For example, if specified ratings of importance of or satisfaction with interlibrary lending and reference services ranges from 1 to 5, the confidence interval for the estimated average level of performance would probably be greater than estimates in which ratings ranged from 3 to 5.

(4) *Statistical sample method.* A survey can be improved in terms of decreasing estimated confidence levels (at a given sample size) by statistical sample methods (e.g., stratification, ratio estimation, etc.).

Examples of one standard error (i.e., 68% level of confidence) for various sample sizes and estimated proportions (%) are given below, assuming a random sample.

Sample Size	Estimated Proportion					
	5%/95%	10%/90%	20%/80%	30%/70%	40%/60%	50%
25	43	60	80	92	98	100
50	31	42	57	65	69	71
75	25	35	46	53	57	58
100	22	30	40	46	49	50
150	18	24	33	37	40	41
200	15	21	28	32	35	35
250	14	19	25	30	31	32
400	11	15	20	23	24	25

Note that complementary proportions (i.e, 95% for 5%, 70% for 30%, etc.) have exactly the same standard errors. This table can be used to determine sample sizes initially or to test approximate statistical precision of survey results For example, if one expects about 30 percent of users to have borrowed books on their last visit and one is willing to accept estimates between 25 percent and 35 percent at 68 percent level of confidence, a sample size of about 85 is sufficient Note, however, that this means 85 completed responses (not the number of questionnaires handed out or mailed). Assume that a sample of 152 responses was received and the proportion of users who used the card catalog was estimated to be 10 percent. The confidence level of this estimate would be about plus or minus 2.4 percent at the 68 percent level of confidence or 4.7 percent at the 95 percent level of confidence

It is important to note that if certain stratum results or estimates are particularly important for stratified random samples, the sample size of that stratum should partially determine sample size. For example, if it is important to know results for R&D professionals, the sample size for R&D professionals should be considered and the table above used as evidence for how many of these professionals to sample.

Non-sampling Error

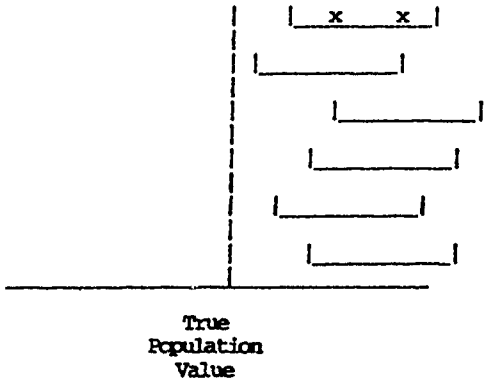
Non-sampling errors are mistakes that creep into survey processes due to the following sources of error.

- Improper questionnaire design
- Development of an inadequate sampling frame
- Errors due to nonresponse from a sampled unit
- Errors in response to questions
- Clerical processing error
- Computing error

- Analyst error
- User error.

These sources of error are discussed briefly below

One can have very precise estimates (with narrow confidence intervals), but be measuring the wrong value. Thus, we would have the picture below which shows confidence intervals given above in the section on sampling errors.



Some examples of sources of nonsampling error and means of controlling them are given below[4].

Questionnaire design. The basic source of errors in questionnaire design involves the evaluator's inability to communicate what data and information are needed and respondents' inability to communicate responses accurately. Sources of error include ambiguous definitions, poor instructions, use of proxy data, and questionnaire wording, format and length. Control of these errors is achieved by careful wording of questions, etc., providing unambiguous instructions, providing a glossary of terms, and doing a pretest prior to final design and data collection.

Questionnaire design for all four types of surveys is a critical element in the chain of events leading to valid and reliable indicators. Most surveys require a data collection instrument or questionnaire. Therefore, procedures should be followed to ensure that correct answers to questions are obtained and errors are not made. Ideally, questionnaires should be pretested by personal or telephone interview, if possible, to discover respondents' understanding of the questions and the instructions given. In addition, the pretests provide an assessment of the duration of the interview or time necessary for respondents. Also, pretests of self-administered questionnaires provide a means for assessing the response rates that can be expected.

In designing survey questionnaires, four basic rules should be kept in mind:

- Ask only for the minimum information required.
- Make sure that the questions *can* be answered.
- Make sure that the questions can be answered *truthfully.*
- Make sure that the questions *will* be answered.

To abide by these rules, the suggestions below should be followed in phrasing questions and in formatting a questionnaire:

1. *Verbiage.* Questions should be phrased using the smallest number of words, everyday words, and words that are unambiguous and make sense.
2. *Complex questions.* Two or more questions should not be disguised under one question expecting a simple answer. For example, one should avoid questions like: "On your last visit to the library did you conduct bibliographic searches using published bibliographies or online searching? — Yes/No." That is three questions in one, and unless three response boxes are set up, answers will be meaningless.
3. *Complex/inverted questions.* Questions should be phrased so that if the respondent agrees with the statement he or she can answer "Yes" (i.e., do not use negatives in such a way as to invert the question).
4. *Recall.* It is difficult for respondents to remember events over, say, one month. The way to avoid this problem is to rely on critical incidents, such as "When did you last conduct an online search?" or "How many online searches did you conduct last month?" These questions are more likely to give reliable answers than "How many times did you conduct online searches last year?"
5. *Concrete facts versus opinions.* Answers to questions about what people actually do are likely to be more reliable than answers to questions about what they like, feel, or want for the future. For example, questions about future purchase behavior or price that respondents will pay for an information product or service are not very reliable.
6. *Use "critical incidents"* of use of services when possible rather than general statements. For example, "What was your level of satisfaction with the response time of your last online search?" is preferable to "What is your level of satisfaction with online searches?"

Above all, when designing questionnaires it is important for the questionnaire designer to visualize how easily the respondent can answer each question.

In physically organizing the questionnaire, it is important that a question be included only if it is essential. Lengthy questionnaires, which the respondent may not see the need for, tend to result in thoughtless answers and lower response rates. It is also important that the first few questions be particularly important questions, ones whose relevance can be seen by the respondent. Extra care should be taken with the substance and phrasing of these first few questions. In order to avoid conditioning answers to subsequent questions by what is asked in earlier ones, it is best to go from general questions to specific questions than to go from the simple to the difficult questions.

Open-ended questions are best placed near the end of the questionnaire so that the closed questions will be answered before the respondent tires. Boring or repetitive questions especially should be placed at the end of a questionnaire to avoid respondent refusal. The objective of organizing the questionnaire is to provide a sequence that is natural and easy for the respondent; therefore, topics and questions need to be arranged in the pattern which makes the most sense to the respondent

One of the biggest problems with surveys is refusal to respond, particularly with self-administered questionnaires.

Ways to avoid nonresponse are to make sure self-administered questionnaires are brief, have good typographic quality, and demonstrate interesting issues. Respondents are unable to understand the relevance of a survey when there are inadequate explanations, badly worded questions, and poorly ordered questions. Personal questions will achieve lower response rates and may contribute to the respondents' refusal of the whole questionnaire. Questions that are not understood by respondents will be refused. Finally, questions concerning attitudes may achieve lower response rates than more straight-forward factual questions.

Almost every survey will require that results be classified into certain groups, so that one can see, for example, how women's behavior differs from that of men, or how R&D professionals use center services, or how level of education affects use of services. The demographic characteristics to include depend on the type of survey being conducted and which characteristics might be related to difference in behavior.

Development of the sampling frame. One major problem is that listings of individuals (organizations or libraries) are often not complete or are out of date. For example, company telephone lists are frequently out of date or do not make a distinction of employees that one must sample (e.g., professionals). Thus, a "target" population or intended population may not be the one sampled. Sometimes, the difference may be judged to be inconsequential. Otherwise steps should be taken to update the list. For example, personnel offices will sometimes provide names of persons recently hired or fired. One common error is that researchers sometimes sample one kind of sampling unit, but actually observe another. For example, information center visitor or "exit" surveys have visits as the primary sampling unit; however, survey measures are taken as though the visitors are the primary sampling unit. This source of nonsampling error can be controlled through proper analysis and weighting methods. Sometimes non-obvious sampling frames must be used. For example, in an information center, a sample of books can be done by systematically sampling catalog cards or linear distance on shelves (e.g., to take books identified every two linear feet). We were recently asked by the Library of Congress to design a sample to estimate the number of books that require special treatment for preservation. We considered taking books every "x-th" feet on the shelves until we found out that there are 526 miles of shelving. Instead we used multi-stage sampling with locations, shelves within locations, and books within shelves serving as levels. Thus, statistical sampling methods can overcome some problems.

Nonresponse error. When surveys are done some individuals refuse or neglect to respond. There are two kinds of nonresponses. One kind is where a respondent refuses or neglects to respond at all (i.e., unit nonresponse) and the other is when the respondent doesn't answer a specific question (i.e., item nonresponse). This happens most often with self-administered questionnaires, less with telephone interviews and least with personal interviews. The problem is that those who choose not to respond to the survey or to specific questions may be different from those who do and, therefore, their responses might be different. For example, for a survey about online search services, users may be more likely to respond than non-users because of interest in the service. However, non-users usually would have fewer questions to answer, which counterbalances the above. Regardless, one must be concerned with this source of error. An example is given below to demonstrate the potential effect of this kind of error. Assume that we are attempting to estimate the proportion of professionals in an organization who are familiar with or aware of an information center service. If we assume an initial sample of 200 professionals and an ending sample of 150 (i.e, 75% response rate) one might have the following results.

75% RESPONSE RATE

Respondents (150)	Non-Respondents (5)	True Value
80.0%	90.0% aware	82.5% true value
	80.0% aware	80.0% true value
	70.0% aware	77.5% true value
	60.0% aware	75.0% true value
	50.0% aware	72.5% true value
	40.0% aware	70.0% true value

This example shows that if the awareness of 150 respondents is 80.0 percent and awareness of non-respondents is 90.0 percent, the true population value is 82.5 percent (or 2.5% above the survey estimate). Even if the awareness of non-respondents was half that of respondents (an unlikely event), the true population value would be 70.0 percent (or 10% below the survey estimate) which, for decision-making purposes, is not appreciable However, one can see as response rates go down the potential error will be exacerbated.

50% RESPONSE RATE

Respondents (100)	Non-Respondents (100)	True Value
80.0% aware	90.0% aware	85.5% true value
	80.0% aware	80.0% true value
	70.0% aware	75.0% true value
	60.0% aware	70.0% true value
	50.0% aware	65.0% true value
	40.0% aware	60.0% true value

25% RESPONSE RATE

Respondents (50)	Non-Respondents (15)	True Value
80.0% aware	90.0% aware	87.5% true value
	80.0% aware	80.0% true value
	70.0% aware	72.5% true value
	60.0% aware	65.0% true value
	50.0% aware	57.5% true value
	40.0% aware	50.0% true value

We always attempt to achieve at least 50 percent response rates. Again, as said elsewhere, it is better to design the survey with fewer responses and devote resources to getting a sufficiently high response rate than to spend a lot on a large sample but achieve low response rates.

The principal methods used to overcome the potential bias created by non-response are imputation and weighting. Imputation is the process of developing estimates for missing or inconsistent data in a survey. If possible, data obtained from other units in the survey are usually used in developing the estimate. Sometimes a cohort is used. For example, if we have surveyed a large information center staff to determine how they spend their time and one staff member did not respond (say, due to an illness) one could choose a cohort (i.e., someone who does essentially the same kind of work) and substitute the cohort's response for that of the nonrespondent. In a larger survey sometimes the overall average is substituted for non- response. This can also be achieved by equally weighting all responses to population totals. For example, suppose we are estimating the

proportion of professionals who are visitors and the total number of visits that professionals make to an information center. Further assume that the population, survey sample, and sample response is 500, 300; and 160, respectively. If the number of respondents who indicate they visited an information center in the past month is 107, we assume that 66.9 percent (i.e., 107 divided by 300) of the nonrespondents are the same proportion of the entire population visited an information center. Similarly, if we observe that the average number of visits is 4.88 per respondent, we can assume that the average number of visits of nonrespondents and, hence, entire population, is also 4.88 visits per month per professional. However, we may have more information to help impute or weight more accurately.

Suppose that the responses for an organization can be accurately subdivided by work role as follows.

Work Role	Population	Initial Sample	Ending Sample	Proportion Who Visited (%)	Avg. No. of Visits
Research & Development	673	50	40	95.0%	7.66
Operations and Other	978	117	40	70.0	5.41
Management	420	61	40	37.5	2.89
Admin., Finance, Legal	429	52	40	65.0	3.58
Total	2,500	300	160	66.9	4.88

Since response rates vary substantially among work roles (i.e., from 34% for operations and other to 80% for R&D) and proportions and averages vary among these work roles, one can use this information to more accurately estimate proportions and averages. The estimated proportion is calculated by multiplying the work role proportion times the total in the population, summing these totals, and dividing by the population total (2,500). Thus, the revised estimate of proportion professionals who visited an information center the past month is 70.4 percent ($0.950 \times 673 + 0.700 \times 978 + 0.375 \times 420 + 0.650 \times 429$). This compares with an estimate of 66.9 percent using raw unweighted results. The weighted average visits is 5.28 visits ($7.66 \times 673 + 5.41 \times 978 + 2.89 \times 420 + 3.58 \times 429$) divided by 2,500. This compares with the raw average of 4.88 visits per month per professional.

Response errors. Sometimes nonsampling errors are incurred because respondents simply respond incorrectly. This can be intentional (e.g., lying about one's age, time spent in an information center, etc.) or unintentional (e.g., just circled the wrong response, remembered incorrectly, etc). Other reasons for unintentional response errors include inability to answer (e.g., a respondent may not know the answer to a question) or it costs too much to answer a question. Response errors tend to increase with the length of a questionnaire. We give some suggestions for minimizing response errors in the discussion above concerning questionnaire design.

Other sources of error. Nonsampling error can occur from clerical processing of survey forms (e.g., sent to wrong address or neglecting to input to processing), coding responses incorrectly, inputting incorrectly, or proofing. Selection and training of clerical staff can go a long way toward minimizing these errors. Also, review of coding, editing routines and validating input can reduce errors. Surprisingly, computer errors can occur due to improper instructions or specifications, rounding or truncation, or improper weighting, aggregation or handling of models. These errors can be detected by calculating some estimates manually. These kinds of errors are more prominent on large government surveys, but should be known by evaluators as well. Errors can occur because of improper analysis and derivation of estimates. Examples are given in Chapters 8 and 9 for overcoming typical errors. Also, one can interpret results invalidly. The best way to avoid these errors is by reviewing analysis (by peers, supervisors or an expert panel). Finally, the results may be misinterpreted by readers (i.e., managers) due to inadequate presentation. Survey results must include adequate description of data attributes, survey methods employed, potential sources of nonsampling error and statistical precision. Of course, one source of user error is when results are misused and this does happen on occasion.

Chapter 8

Evaluating the Effectiveness of Information Centers

8.1 Background

We begin by referring back to the framework for evaluating information center performance and effectiveness in Figure 4 in Chapter 2. In the framework we show that one can characterize user's work by the activities they perform (e.g., primary research, engineering, legal work, management, etc.) and resources they use to do their work (e.g., their time, equipment, support staff, information, etc.). Their work can also be characterized by input costs and output quantities and attributes (e.q., quality and timeliness of work). One can relate the use of information (in general) and information and services provided by information centers (in particular) to input costs and output of users' work. We refer to such a relationship as higher order effects of information and information services. Evaluating higher order effects of information and information services is the topic of Chapter 10. This chapter focuses on measuring and evaluating the extent of use of services and factors that affect the use of services. Such factors include inherent need for information and services, awareness of services, availability and accessibility of services, satisfaction with service attributes, price of services, and competition for service provision. Extent to which information centers provide information and services is characterized by (D) and the extent to which service attributes affect use is characterized by (f) in the framework in Figure 4.

There are three types of surveys that can be used to measure the use and performance of information center services[4]:

- survey of the general user population (General User Survey),
- survey of known information center users (Patron or Visitor Survey), and
- survey of known users or uses of specific services.

For complete evaluations we suggest conducting at least two of these surveys. The first two types of surveys are described below. The surveys involving specific services are discussed in the next chapter.

8.2 General User Survey

The purpose of the general user survey is to obtain information about:

- number of users and extent of use of the information center,
- number of users and extent of use of specific services,
- importance of and satisfaction with specific services,
- awareness of specific services,
- satisfaction with staff competence (knowledge, skills, and attitude),
- suggestions for improvement in services and service attributes, and
- relevant user characteristics and demographics.

This survey involves a statistical sample from the entire population of the user community being served such as the employees of a company or government agency, specific types of professionals such as scientists and engineers, or potential organizations and their employees served by a clearinghouse. The reason that the entire population is surveyed, rather than just users, is that by doing so one can obtain valuable information about non-users and the reasons they do not use the information center or specific services.

Suggestions for sample design are as follows:

- *Sample frame.* In a company or government agency the personnel department can usually provide a listing of employees, sometimes categorized by useful information. We often limit the sample frame to certain population segments that are highly likely to be information center users. For example, often only professionals in organizations are sampled This excludes non-professionals such as secretaries, laboratory technicians, clerical staff and other types of support staff. It is important to recognize that non-professionals sometimes use libraries to support their work and, if they are excluded, estimates of use will be understated. Secondly, support staff often use an information center on behalf of professionals. This potential survey weakness can be addressed by the way in which use-related questions are asked (see the section on questionnaire design below).

  If an information center serves a general community (e g., an information clearinghouse or national library), the sampling frame may have to be developed from one of several sources. A common source is directories of organizations or libraries in organizations. In the U S., for example, one can use listings (or samples) of firms provided by Dun & Bradstreet, American Library Association, Special Library Association, and other directories of company, agency, academic institution, and other organization libraries and information centers. The sampling frame can also be developed from listings of individuals such as members of professional societies. When multiple listings are used one must be careful to take into account organizations or individuals who appear on more than one list, otherwise their responses will be biased. (See discussion under sample design below).

- *Sample design.* For sampling employees in organizations, we find that there is usually sufficient information provided by personnel listings that one can stratify the sample to improve the precision of survey results. That is, stratification takes into account factors that are related to extent of use of services. Such factors include:
  - *Location* If an organization has multiple sites, it is useful to stratify by sites that do and do not have information centers.

- *Level of employee.* As mentioned above, if classification is available, it is useful to stratify by professional, paraprofessional (e.g., laboratory technician, executive secretary and clerical) or other support.
- *Work role.* Some organizations can quite easily categorize their employees by work role such as research, engineering, management, administrative, operational, etc.

If the purpose of stratification is to present data and analysis by the stratification factors, then one should sample equally from each strata. If the purpose of stratification is to improve precision, then sampling from the strata should be roughly in proportion to the expected amount of use. An example is given below for a two-way stratification where one strata factor is work role (sampled equally) and level of employee (sampled in proportion to likely use). In the example, we give population and sample sizes (N/n).

POPULATION AND SAMPLE SIZE FOR TWO-WAY STRATIFICATION

	Work Role					
	Research	Engineering	Management/ Executive	Administration	Operations	Total
Professional	960/60	1,920/80	240/60	570/60	680/60	4,360/300
Para-professional	460/30	960/30	120/30	230/30	920/30	2,680/150
Support	350/10	570/10	160/10	460/10	1,340/10	2,900/ 50
Total	1,760/80	3,440/80	520/80	1,260/80	2,940/80	9 940/400

If the sampling frame is of organizations, then a two-stage sample might be necessary. By two-stage we mean that organizations (e.g., library) is sampled as the first stage and end-users or individuals (e.g., professionals) in the organization are sub-sampled as a second stage. The second stage or individual sample can be done by having a designated person in the organization select a sub-sample of users or persons found in their organization. A librarian is a good person to do the sub-sampling. Normally, one would sub-sample in rough proportion to extent of use, however, because of the burden to the designated sampler we normally have them choose the names of 3—5 persons and either submit the names to the researcher to survey or have the sampler forward the questionnaire to the sampled persons to be returned to the researcher. One can also ask the librarian to send a telephone directory of the organization or 3 or 5 pages chosen randomly from such a directory and then the researcher can choose a more proportional sample and not burden the librarian further.

As mentioned above, one problem arises when a sample is drawn from listings in which individuals (or organizations) can appear on more than one of them. Suppose, for example, one has three lists from which to sample: a list of known users, a list from the American Chemical Society (ACS) and a list from American Institute of Physics (AIP). Sampled individuals could possibly be on any of the following combinations of lists (with number respondents given in parentheses):
— User only (30)
— ACS only (15)
— AIP only (25)
— User, ACS (66)
— User, AIP (50)
— ACS, AIP (25)
— User, ACS, AIP (10)

These combinations can be considered seven strata and treated as a stratified random sample, only the strata are established after responses come in (i.e., post-stratified sample). First, one must estimate the population totals from each stratum. This can be done by random sampling from each list and then estimating strata totals by determining the identity of the lists each respondent belongs to. This can be done by cross-checking lists or by having the respondents indicate if they use the service and are members of ACS and/or AIP. Assume that list sizes and sampled respondents are as follows: users — 4,000/150; ACS — 32,000/100; AIP — 18,000/120. Note that only certain sections of ACS and AIP might be sampled. The way in which the sampled respondents are partitioned is given in the parentheses for each of the seven combinations above. Rough equations for estimating strata totals (combinations) are as follows:

User, ACS N(UC) = (4,000 × 50 + 32,000 × 5) divided by 250 = 1,440

User, AIP N(UI) = (4,000 × 60 + 18,000 × 10) divided by 270 = 1,560

ACS, AIP N(CI) = (32,000 × 25 + 18,000 × 55) divided by 220 = 8,140

User, ACS, AIP N(UCI) = (4,000 × 10 + 32,000 × 1 + 18,000 × 2) divided by 370 = 290

User only N(C) = (4,000—1,440—1,560—290) = 710

ACS only N(C) = (32,000—1,440—8,140—290) = 22,130

AIP only N(I) = (18,000—1,560—8,140—290) = 8,010

More complex and accurate equations can be used, but the equations above are adequate approximations. Once totals for the seven strata are estimated, statistical weighting should be applied for all estimates just as done for stratified sample surveys. (See Chapter 7).

- *Sample size.* The sample size should be determined by the level of precision required for the survey. One can refer to the table in Chapter 7 for an indication of level of precision achieved at different sample sizes. There are some aspects of sample size that should be remembered:
  - The relevant sample size is the actual responses and not initial sample (i.e., mailout or respondents sampled). One should attempt to achieve at least 50 percent response rates and, therefore, if a sample of 150 is desired, one should sample around 300. Also, questionnaire response rate is often higher than item (i.e., question) response rate because some questions will not be answered by some respondents.

— If one is particularly concerned about a subset of respondents (e.g., research work role or persons at remote site) the relevant sample size refers to those subsets. One should attempt to have at least 15 to 25 responses in relevant subsets.

Generally, sample size can comfortably be about 200 responses for most user surveys. Note that some information gathered in the General User Survey (e.g., extent of use of information center, work role) may be combined with other survey results so that the combined survey sample size is the one that should be considered appropriate.

- *Random Sampling Procedures.* Assuming that lists can be obtained, the best method for sample selection is normally systematic sampling with random start. That is, one merely needs to determine a sampling interval, select the first sample randomly and then take every nth unit on the list. For example, referring to the table above giving population and sample size for two-way stratification, there are 950 professionals who do research and we want to sample 60 of them. The sampling interval would be 16 (950 divided by 60) so that a number between one and 16 would be chosen from a table of random numbers. If the number is four the sample would be 4, 20 (4 + 16), 36 (20 + 16), etc.

- *Data Collection Methods.* This survey would normally be done by mail and self-administered, but it could also be done by telephone or personal interview. The advantages and disadvantages of these three data collection methods were discussed in the previous chapter.

8.3 Amount of Use of Information Centers

Amount of use of information centers is a critical measure because it is an indicator of the usefulness of them and it serves as a means of diagnosing performance of services. Of course, the best means of measuring use of internal information centers is by gate counts and logs of other kinds of contacts such as by calling, writing and so on. However, most information centers do not keep such information on a regular basis. A second way to measure use is through a sample of visits and uses through other means. This method is discussed in the next chapter. A third method is to determine amount of use through a General Population Survey. In this survey one should survey the extent of use of alternative sources to information centers in addition to the information center or centers being evaluated. For example, within a company or agency there may be a main information center and centers located at two additional sites. In addition to these three centers of interest there may be "local" office collections of books, reference materials and journals. These collections may be maintained by a secretary, laboratory technician or other support staff. We have found that such collections are valuable resources that, along with personal subscriptions to journals and other materials as well as information centers, can achieve optimum allocation of materials across the entire organization (see Chapter 12 for further discussion of this issue). Alternatives to information centers in an organization are external libraries and information centers such as academic, public and government libraries and government clearinghouses.

Ability of respondents to remember their number of uses in the past (i.e., recall) is a problem with asking about amount of information center use. Therefore, the length of period over which use is determined depends on how much use is made of information centers. If use is high the period could be one week. That is, one would ask how many times the information center was used in the last week. If use is low the period could be as long as a year. We have found that one month is best for most organizations. The problem with using a period less than a year is that the "last" week or the "last" month may not be typical if there are seasonal affects such as are common with academic institutions or in December holidays. Thus, the survey should be done at a time that will yield accurate results when the week or month period is extrapolated to a year.

There are two basic ways of asking respondents for their amount of use. One is by pre-coded ranges of amount of use and the other is by having respondents record their recollection of approximate amount of use. We have found that one should ask for "approximate" amounts, because some respondents (particularly some scientists and engineers) will be "turned-off" by the survey because they will not know exactly how many times they used the center Also, we have found that it is useful to ask for both number of visits to the information center and additional uses such as by calling, writing, etc. Finally, it is important to specify that the uses are for the respondents own work-related activities and that the number of uses should include instances where someone else (e.g., a secretary or other support staff) uses the information center at the respondent's request or on behalf of the respondents.

Examples of how this question might be asked are as follows:

Q. Approximately how many times in the past month have you or someone on your behalf visited information centers, libraries, or local office collections for your work-related purposes and how many additional times have you used them by calling, writing, etc. to obtain information, order documents, or other purpose? Include visits or additional uses that are made by someone else (e.g., secretary or other support staff) at your request of or on behalf of someone else. If you did not use an information center, library or "local" office collection in the LAST YEAR, please check here and skip to Section X on page Y. _____ Go to page Y.

Information Centers/ Libraries/ Collections	Number of Uses LAST MONTH	Number of Additional Uses LAST MONTH
Main Information Center	____times last month	____times last month
Information Center A (located at site X)	____times last month	____times last month
Information Center B (located at site Y)	____times last month	____times last month
A "local" office collection	____times last month	____times last month
An academic library (e.g., at Z University)	____times last month	____times last month
A public library	____times last month	____times last month
A government library	____times last month	____times last month
A government information center	____times last month	____times last month

OR

Q. Approximately how many times in the past month have you or someone on your behalf visited information centers, libraries or local office collections for your work-related purposes and how many additional times

have you used them by calling, writing, etc. to obtain information, order documents, or other purpose? Include visits or additional uses that are made by someone else (e.g., secretary of other support staff) at your request. Do not include visits or additional uses you made at the request of or on behalf of someone else. If you did not use an information center, library of "local" office collection in the LAST YEAR, please check here and skip to Section X on page Y. _____ Go to page Y.

Circle Appropriate Code

No of Times	Visits	Additional Uses	Total Uses
2-3	1	1	1
3-5	2	2	2
6-10	3	3	3
11-25	4	4	4
Over 25	5	5	5
(Please specify)	____	____	____

Some additional notes concerning this question. It is important to establish acceptable terminology for this question during initial in-depth interviews (see Chapter 7 for a discussion of this method). This applies to names and/or locations of information centers and libraries. Also, "local" office collections might be more commonly called "unit collections," or "laboratory reading rooms" in an organization. The skip pattern is used to avoid the necessity of requiring non-users to answer questions concerning use. One can make provision through the skip pattern to avoid irrelevant questions. We assume that someone who hasn't used an information center or library in the last year can be considered a non-user. Finally, one can refine estimates of total use over an entire year by asking respondents the number of days they were at work in the last month to account for sick leave, holidays, or vacation. The responses can be adjusted by the following means:

- Assume 13 days worked in the month reported, a response of 6 items the last month reported, and 220 normal work days (without sick leave, holidays, etc.) in a year.
- Adjustment to an annual total would be 220 divided by $13 \times 6 = 101.5$ times per year.

Thus, for this measure the respondent is estimated to visit the information center (or other facility) 101.5 items in a year. This value would be imputed to the respondent and analysis performed using these imputed data.

Average number of visits (or additional uses) would be found by summing annual estimates of responses[1] divided by number of respondents (including non-users who skip to later questions because they did not use an information center in the last year). Total visits is calculated by multiplying average visits per person times the total number of persons in the population sampled.

Average and total visits (or additional uses) calculated from pre-coded ranges is less precise, but can be done by using the following calculations (assuming one month):

[1] By multiplying responses by 12 or a refined value as calculated above.

No of times	Prop of responses	Estimated mean
0	0.30	0
1-2	0.22	1.41
3-5	0.19	3.87
6-10	0.15	7.75
11-25	0.10	16.58
over 25	0.04	32.65

The data above are actual data. The mean of an interval can be approximated by the mid-point (e.g., 1, 2, = 1.5; 3—5 = 4.0; etc.) or by using a geometric mean[2] calculated by taking the square root of the product of the end-points of the range. For example, the geometric mean of the 1, 2 range is square root of $1 \times 2 = 1.41$; 3—5 range is square root of $3 \times 5 = 3.87$; etc. The estimated mean of the data above 25 visits is calculated from actual reported data. The overall mean is found by summing the cross products of number of responses times estimated means for each range and dividing by the total number of responses. Average annual use is then found by multiplying the monthly average by 12. The estimated average for the data above is:

$(.30 \times 0 + .22 \times 1.41 + .19 \times 3.87 + .15 \times 7.75 + .10 \times 16.58 + .04 \times 32.65) \times 12 = 62.06$

One particularly important factor involving the extent to which an internal information center is used is the distance of users to the center. This is a measure of accessibility of a center and its services. Distance can be measured in several ways including:

- linear distance such as number of feet (or even miles) that a user is to an information center,
- number of floors away (if appropriate), or
- number of minutes away.

We have found that, by far, the best measure is in time (i.e., minutes away) because time of professionals is a scarce resource. They are very aware of their time and how much time it takes them to get to an information center In a real sense the time users spend going to an information center and in using its services is a measure of the "price" they pay for the center or the "value" they place on the information and services. As the time (distance) to the center is increased the use decreases because the "price" increases. Just as demand for consumer products decreases as price increases, the use of information centers decreases as its "price" increases. Methods for measuring distance to information centers are discussed below.

Distance (in time) can be asked in the demographic section of the questionnaire or it can also be added to the question concerning number of visits and number of additional uses. Examples are given below for these two methods.

Q Approximately how far *(in minutes)* is your *office/lab* from the Information Center?

_____ Minutes

OR

[2] Geometric mean is a good approximation for log-normally distributed numbers (i.e., highly skewed numbers).

Information Center	No. of Visits LAST MONTH	No of Additional Uses LAST MONTH	Distance to the Center
Main Information Center	____ times last month	____ times last month	____ minutes

Note that we did not include a skip pattern for non-use because it may be that a long distance to an information center results in non-use. This hypothesis can only be examined by comparing distance of users with distance of non-users.

We find that professionals generally will use a variety of sources for their information and information services and this is as it should be since an organization's information center should not be expected to fulfill all information needs. However, if over about 10 to 15 percent of visits and additional uses of a center's potential patrons come from external sources (e.g, academic libraries) there may be a problem. The reason that we say there may be a problem is that non-organization information sources tend to be expensive in terms of users' time Some use is expected; for example, an employee may be in night school and may use the academic library for work-related purposes or a professional may know about a book that is in the public library, etc. However, extensive external use can be very expensive to an organization. Extensive use of alternative sources also suggest that there may be a problem with the performance of the information center. There are many factors that affect use of an information center and if certain use criteria are not met by the information center, professionals will seek alternative source.

Factors That Affect Use of Information Centers

Factors that affect use of information centers and their services include:

- inherent need for information and services,
- availability of information and services at the information center and alternative (competitive) sources,
- awareness of center and its services,
- importance of services, and
- performance of information center services.

In this section we provide examples of how one can measure these factors by surveys and, in Chapter 11, we show the relationship of these factors and extent of use of the information center and its services. First, we list examples of information services and then examine how to measure use of the services and the factors above that affect use.

Information center services are grouped as follows:

- *Access to information center facilities:* Research and reading rooms, study carrels, disabled facilities, etc.
- *Access to collections and materials:* Access to library books, journals, patent documents, reference materials, internal technical reports and other documents, external documents such as government reports, audio visual materials, cartographic material etc; journal routing; access to journal articles through interlibrary loan or document delivery; centralized purchase of books, journal subscriptions, professional society membership, etc.
- *Access to information equipment and systems:* Online bibliographic and numeric database searching systems available to users, online catalogs, terminals or PCs, audio-visual equipment, microform viewing equipment, photocopy equipment, etc.
- *Reference and referral systems:* In-depth research, search of reference materials, online bibliographic and numeric database searching, online searching of internal documents, referral searches, etc.; current awareness services; selective dissemination of information (SDI); and so on.
- *Other services:* Document translation, archives or organization records, internal document publishing and distribution, organization electronic bulletin board, orientation and training, etc.

This list of services is not intended to be exhaustive, but rather indicative of the kinds of services that might be evaluated.

One can ask a series of questions for each service concerning:

- extent of use of the service and alternative sources to the service,
- awareness of services,
- availability and accessibility of services,
- importance of services, and
- satisfaction with attributes of output such as quality and timeliness of services.

However, if evaluation involves a substantial number of services such a series of questions can make the questionnaire unacceptably long. Instead these questions can be grouped as demonstrated below.

The series of questions might involve awareness and use of services. An example of a survey question concerning these factors is given below:

Q. The question below deals with your awareness and use of Information Center services. Even though you may be an Information Center user, you may not be aware of or use all of its services. A list of services are given below.

Please indicate (by circling appropriate numbers) if you are aware of the service (and have used it — 1 or have never used it —2) or that you are not aware of the service (and have no need for it — 3 or have a need for it — 4). Also, record the number of times you have used the service in the last month and the number of times you have used another source for the service in the last month (e.g., an academic library, a "local" office collection; etc.).

Aware of Service		Not Aware of Service		No. of Times Used LAST MONTH	
Have Used	Have Never Used	Have no Need for Service	Have Need for Service	Information Center	Other Source
SERVICE					
Research and reading rooms	1	2	3	4	___ ___
Read or used collection of books, journals, etc. in center	1	2	3	4	___ ___
Checked out (borrowed) materials from collection in Center	1	2	3	4	___ ___
Copies of articles from interlibrary loan or document delivery services	1	2	3	4	___ ___
Centralized purchase of books, journals, etc.	1	2	3	4	___ ___
Online catalog in Center	1	2	3	4	___ ___
Photocopy equipment	1	2	3	4	___ ___
Telephone reference service	1	2	3	4	___ ___
Online searches conducted by Center staff	1	2	3	4	___ ___
Access to microform equipment	1	2	3	4	___ ___
Translations of articles etc	1	2	3	4	___ ___
Used Electronic Bulletin Board					
• Sent messages	1	2	3	4	___ ___
• Received messages	1	2	3	4	___ ___

One can be more specific for some services. For example, for the question "read or used collection of books journals, etc. in the Center" could be subdivided into:

- Read or used collection of materials in the Center:

Aware of Service		Not Aware of Service		No. of Times Used LAST MONTH	
Have Used	Have Never Used	Have no Need for Service	Have Need for Service	Information Center	Other Source
SERVICE					
Current periodicals	1	2	3	4	___ ___
Current books	1	2	3	4	___ ___
Periodicals in compact storage	1	2	3	4	___ ___
Books in compact storage	1	2	3	4	___ ___
Laboratory notebooks	1	2	3	4	___ ___
Organization technical reports	1	2	3	4	___ ___
Reference materials	1	2	3	4	___ ___
Audio-visual materials	1	2	3	4	___ ___
Cartographic materials	1	2	3	4	___ ___

Also, if the list of services is felt to be too lengthy it is possible to sub-divide the services and actually conduct two surveys for two lists of services.

Information and measures provided by the above questions include:

- Number of persons who use the service
- Number of persons who are *not* aware of the service and, more importantly, who also have a need for the service. This provides and indicator of how much additional use might be created through publicity or marketing. By linking (1) those not aware but have a need to (2) Center users/non-users and (3) demographics such as location one has strong evidence to focus publicity to appropriate market segments.
- Number of uses (output) of services and the extent to which alternative sources are used for obtaining the services.

Number of uses of services can be related to importance and performance of services and output attributes.

Calculations for the factors above are straight-forward. The awareness of services can be done as a proportion since respondents must circle 1, 2, 3, or 4. The proportion of respondents who circle 1 gives an estimate for the proportion of users of that service. The estimated total number of users is calculated by multiplying this proportion times the number of professionals in the sampling frame. The proportion of respondents who circle 3 and 4 gives an estimate of the proportion who are unaware of the service and 4 gives the proportion who are unaware and have a need for the service. Inherent amount of use of the service is also indicated by the sum of the amount of use through the center and other sources. Averages and totals for all uses of the service as well as amount of use of the service obtained from the center and from other sources are calculated using the same methods as those given above for amount of visits and additional uses of the information center.

Both importance of and satisfaction with services can generally be measured and we recommend that these measures be done as shown below. In this way, one can compare among all services; for example, for resource allocation. However, we strongly recommend that a separate survey be done for some services using a critical incident method discussed in Chapter 9. General evaluation of importance and satisfaction can be measured by the following survey question:

Q We are interested in your assessment of the importance of Information Center services *THAT YOU USE* for your work and in your satisfaction with these services.

Please rate the importance of and your satisfaction with Information Center services. NOTE: RATINGS OF IMPORTANCE AND SATISFACTION (1 to 5) BELOW.

Importance: Not at all important — 1 to Very Important — 5
Satisfaction: Very Dissatisfied — 1 to Very Satisfied — 5

Again, one can expand on the services as shown above for the collection of materials. Also, it may be useful to establish general importance and satisfaction with specific output attributes of services such as:

Service/ attributes	Circle if you do not use service	Record your rating of importance here (1 - 5)	Record your rating of satisfaction here (1 - 5)
Collection of books, journals, etc	1	___	___
Extent of subject coverage	1	___	___
Number of items within subject covered	1	___	___
Currency of items in collection	1	___	___
Accessibility of items in compact storage	1	___	___

We believe that importance and satisfaction with output attributes of some services, such as online searches conducted by Center staff and translation, should use critical incidents of use of the service and probably should be done by separate survey (see Chapter 9).

Finally, the General Information Center survey can address availability of the Center (and services), competence of Center staff and specific attributes of the Center. Examples of importance of and satisfaction with these factors are given below.

Q Please rate the importance of and your satisfaction with the Information Center facilities and staff. NOTE: RATINGS OF IMPORTANCE AND SATISFACTION (1 to 5) BELOW.

Importance: Not at all important — 1 to Very Important — 5
Satisfaction: Very Dissatisfied — 1 to Very Satisfied — 5

Attribute	Record Your Rating of Importance Here (1 - 5)	Record Your Rating of Satisfaction Here (1 - 5)
Hours that the Center is open	___	___
General ambience of the Center	___	___
Availability of Center staff	___	___
Responsiveness of Center staff	___	___
Knowledge of Center staff	___	___
Skills of Center staff	___	___
Attitudes of Center staff	___	___

Importance of and satisfaction with these two resources (i.e., facilities and staff) can be related to operational performance measures discussed in the previous chapter.

Estimates of the proportion of users who are satisfied (dissatisfied) with services or who consider the service to be important to their work are discussed below. Also, average ratings of importance and satisfaction can be calculated as well. Since calculations for importance and satisfaction are the same, only one example is given below. Also, in the example the scale of ratings is from 1 to 7 instead of 1 to 5 as above.

Satisfaction with Service	Response	Number of Responses	Proportion Responses (%)
Very Dissatisfied	1	2	2 4%
	2	5	6 0
	3	6	7 1
Neutral	4	13	15 5
	5	19	22.6
	6	28	33 3
Very Satisfied	7	11	13 1
Total		84	100 0

In this example, 15.5 percent of the respondents are dissatisfied with the service and 69.0 percent are satisfied with it. The average satisfaction rating can be calculated by summing responses of ratings (422) and dividing by sample size (84) which gives 5.02 average satisfaction rating

Another quick method of calculating the average satisfaction rating is to cross multiply the proportions (not %) times responses and sum them (i.e., $0\ 024 \times 1 + 0.060 \times 2 + 0.071 \times 3 + 0.155 \times 4 + 0.226 \times 5 + 0.333 \times 6 + 0.131 \times 7 = 5.022$). The median rating is 4.94. That is one-half of the responses are above 42.5 and one-half below that number. Thus, the median is between 4 (26 responses) and 5 (45 responses) and 42.5 is 0.94 of 45 (42.5 divided by 45). The median rating is estimated as $4 + 0.94$ or 4.94.

The final set of questions deal with demographics or characteristics of the respondents. There are two general purposes for establishing these characteristics:

- The first purpose is to generally characterize the population served and to compare sample responses to determine if the responses appear to be "representative" of the overall population. This purpose is useful, but not as important as the second purpose.

- Characteristics of persons in the population served should help explain differences in use of information centers and their services.

For example, information seeking behavior varies considerably, by work role, educational background, location, and age. Subdividing the population into groups that reflect use is referred to as segmenting the market. Presently, with knowledge of usage patterns in market segments, information center managers can take some corrective action to increase use such as by locating small centers in underserved sites, publicizing unfamiliar services to certain segments, improving performance of services to segments that are more discernable with service attributes (e.g., medical, legal, scientific), and so on.

Examples are given below for demographic questions we have found to be useful.

Q What is the highest degree you have earned?

Associate 1
Bachelor's (B.A., B S., or equivalent) 2
Master's (M.A., M S., M B.A. or equivalent) 3
Doctorate (PH D., Sc D., or equivalent) 4
Other (describe)_____
_____ . . . 5

Q. In what year did you receive your last/highest degree? 19_____

Q. What is the one field of science or other profession which best characteizes your area of work? (If more than one applies, please indicate the *one which best characterizes the application* of your work).

Science and Engineering
- Physical Science (Chemistry, Physics, etc) 1
- Mathematics, statistics 2
- Computer Science 3
- Engineering 4
- Other Science (specify) _____ 5

Business
- Management 6
- Business 7
- Accounting 8
- Finance 9
- Law 10
- Liberal Arts 11
- Other (specify) _____ 12

Q. Which category best describes the work role in which you spend the largest proportion of your time?

- Management 1
- Research & Development 2
- Education/Training 3
- Operations 4
- Administration 5
- Finance 6
- Legal 7
- Other (describe) _____ 8

Q. What is your current location (names of sites)? _____

We often also ask respondents to indicate any special recognition they have received. For example,

Q. Have you ever received any awards or special recognition at X Company?

- Yes 1
- No 2

If yes, which awards or special recognition?

	Circle all that apply
Company's Top Award	a
Named Research Fellow	b
Director's Award	c
Patent Award	d
Suggestion Award	e
Other (please specify) _____	f

This question provides an indicator of the value of information and of the use of information center services.

Also some general questions concerning information-seeking might be asked in the demographic section of the questionnaire. For example, general awareness of the information center and journal subscription questions might be asked here, as follows:

Q. Prior to this survey were you aware that the X Company has libraries for general use by employees?

- Yes 1
- No 2

Q. How many personal subscriptions to professional journals do you receive? (By personal subscription we mean one which is personally addressed to you at your home, office or lab.)

- Paid for entirely by you . . . . _____ subscriptions
- Paid for entirely by Company . . . . _____ subscriptions
- Shared by you and someone else . . . . _____ subscriptions

Finally, a sensitive question deals with salary. We ask this question to relate user time to cost or the price paid for information and information services. Some organizations object to this question and, in others, the question is optional as follows:

Q. OPTIONAL
What range represents your total compensation (i.e. company salary and/or other employment income such as awards, etc.) in the last year?

- Less than $25,000 1
- $25,000 - $34,999 2
- $35,000 - $44,999 3
- $45,000 - $54,999 4
- $55,000 - $64,999 5
- $65,000 or over 6

The method for calculating average salary when using ranges is the same as that described above for distance to information centers. If an organization does not want to include salaries, an average can usually be found from elsewhere in the organization (e.g., budget or personnel office). However, it is sometimes useful to apply the respondent's salary with the response for each relevant question. For example, suppose we want to place a cost for going to the information center in order to determine if "branches" should be established at certain sites. One knows how much time of each respondent is currently spent going to information center and alternative sources. One can also estimate how much time would be spent with a local branch. Then each respondent cost can be calculated by the following calculation method:
Estimated Total Cost = Estimated annual number of visits x distance to the center (minutes) x 60 x salary rate per hour.

The salary rate per hour is found by dividing total compensation (plus an amount for fringe benefits) by number of hours actually worked in a year (e.g., 2080 minus hours of sick leave, vacation and holidays). In the U.S., a typical hourly rate (including fringe benefits) for professionals is $30.00 to $38.00 per hour.

The effects of market segments can be analyzed by merely cross-tabulating important measures with responses from the segments of interest.

8.4 Survey of Known Information Center Users

There are basically two ways to administer information center user surveys. The first method is to sample a list of known users, for example when there are registration lists or lists of clearinghouse subscribers or users. Government agencies are more likely to maintain such lists than

companies. Even when they are maintained, such lists are often outdated. If such a list is available and sample forms available, one can apply survey questions discussed previously. A second method for internal organization centers is to sample visitors and/or additional users of the information center. This survey provides general measures of frequency of use of the information center and of specific services, importance of and satisfaction with access to resources (e.g., staff, equipment, collection, etc.) and services, distance of users to the information center, and user characteristics. This survey should be conducted periodically over time (e.g., quarterly) and analyzed once a year to provide best results and to minimize seasonal effects.

The visitor survey (sometimes called exit survey) is relatively simple to administer. Once a questionnaire is designed and tested, it is necessary only to establish a sampling scheme by which sampled visitors can be handed questionnaires to be filled out in the center or mailed (or returned at a later visit) if the visitor cannot (or will not) complete it on site. There are two difficulties with this kind of user survey.

- The first difficulty is being able to weight or project results to annual totals since the unit sampled is visits (or uses) and not users. Thus, it is useful for the center to maintain accurate data on total number of visits during the time the survey is being conducted (e.g., a week), although some information centers maintain "gate counts" of visits over a year. This information is important for estimating annual visits and number of users.

- Second since the unit that is sampled is visits, one must distinguish between questions dealing with visits (e.g., number of times a card catalog is used) and users (e.g., user's satisfaction with aspects of the collection, user's work role, etc.).

It is more difficult to estimate both number of visits and number of users through visitor surveys, although the survey itself is generally simpler to administer and is less expensive than general use and population surveys. Visitor surveys must be stratified by number of visits per year (or month) because sample selection is based on visits and not users. Thus, frequent visitors (users) have a greater chance of being sampled than infrequent visitors.

As described previously, number of visits can be asked on the visitor questionnaires in several ways:

Q. How many times have you visited this information center in the past year (i.e., 12 months)?

_____ times last year

Q. How many times have you visited this information center in the past year (i.e., 12 months)? (Please circle as appropriate).

1 - 5 times 1
6 - 10 times 2
11 - 15 times 3
16 - 20 times 4
More than 20 times (specify how many)
_____ times 5

Q. How often do you (or would you if new to the area) visit this information center? (Please circle one).

Less than once a year 1
Once a year 2
Several times a year 3
Once a month 4
Twice a month 5
Once a week 6
Twice a week or more (specify approximately how many times a week) ____ times/week 7

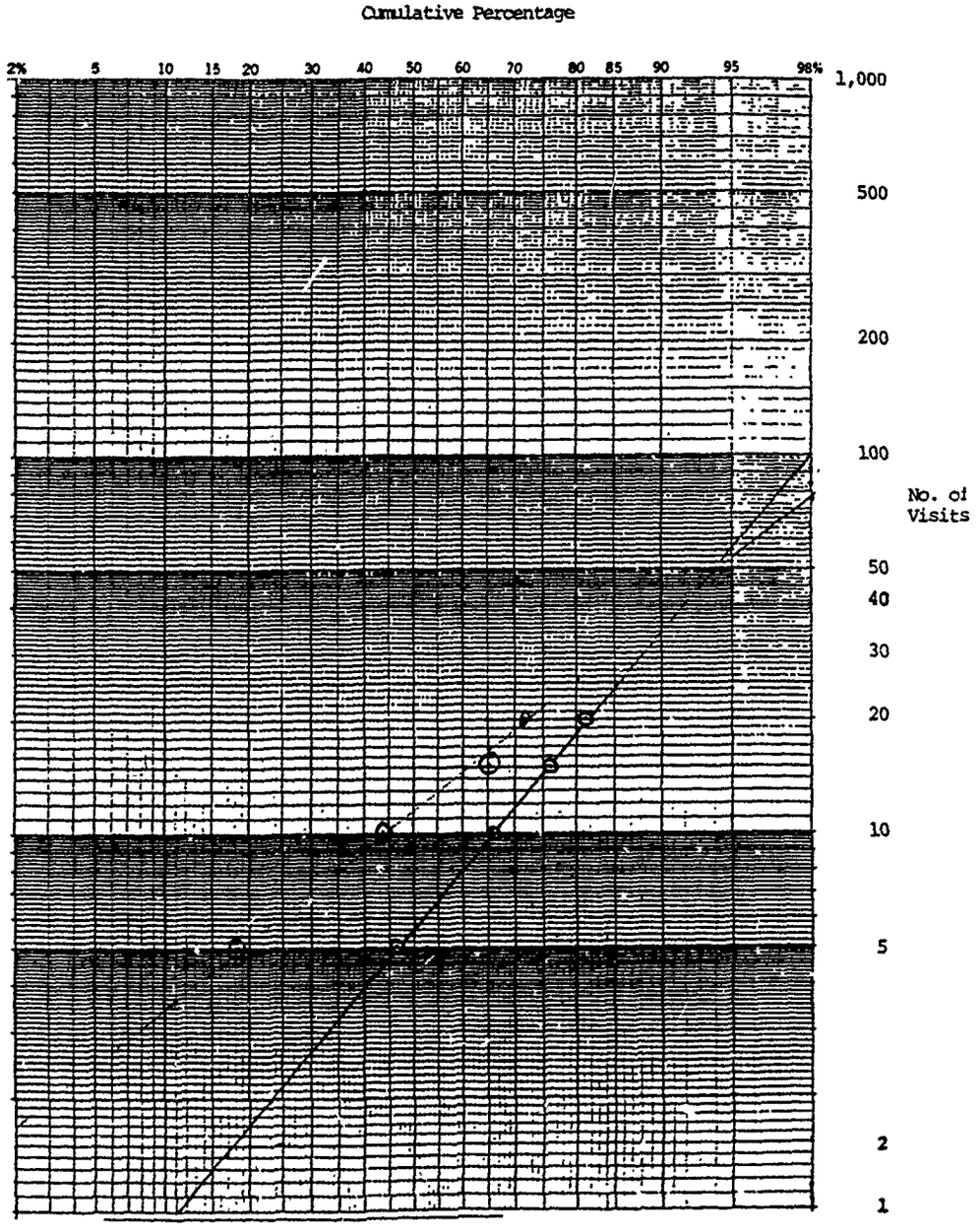
To estimate total and average visits or total users it is necessary to post-stratify by number of visits. An example is given below for the second method of asking number of visits. In this example visits are sampled over a one-week period. A total of 301 visits to the center are counted during this period. A total of 152 visitors answered the number of visits question as follows:

No. of Visits	No. of Visitors	Estimated Total No. of Visits	Estimated Ave. No. of Visits per User	Estimated Total No. of Users
1-5	28	2,884	2.2	1,311
6-10	39	4,017	7.7	522
11-15	32	3,296	12.8	258
16-20	11	1,133	17.9	63
More than 20	42	4,436	39.5	112
TOTAL	152	15,766	7.0	2,266

Of the 152 visitors sampled, 28 visitors said they visited 1 to 5 times, 39 said they visited 6 to 10 times, etc.

The estimated total number of visits is found by multiplying the number of visits in each class of number of visits (e.g., 1—5 visits per year) by a weight of 103 (i.e., 52 weeks times 301 total visits per week divided by 152 sampled visits). The weight is merely the estimated total number of visits to the center in a year (i.e., 52 times 301) divided by sampled visits (152). Thus, the estimated total number of visits by users who visit between 1 and 5 times per year is 2,884 (i.e., 28 sampled visits times a weight of 103). The estimated total number of users who visited the information center this frequently (i.e., between 1 and 5 times per year) is found by dividing the estimated total number of visits (e.g., 2,884 total visits for those who visit 1—5 times per year) by the average number of visits (e.g., 2.2 visits per person per year). Assuming that no one user was sampled more than once in the period or filled out more than one questionnaire, the average in the 1—5 visits class can be calculated in the same manner as any average (i.e., the sum of observations divided by the sample — 28 visits). However, when responses are given as a range one must estimate that average in another way. If the number of visits is log-normally distributed a good way to calculate the average is by using the geometric average, assuming log-normality is reasonable.

A geometric average is found by calculating the square root of the product of the range point (e.g., square root of 1 times 5 = 2.2, square root of 6 times 10 = 7.7; etc.). Unless one actually has values specified for more than 20 visits (as shown in the example above), the average number of visits for those who visit more than 20 times per year must be calculated by extrapolation of the log-normal distribution as shown in the figure on the next page. The fact that the plot is



nearly straight means that the assumption of log-normality is valid (at least in the range given). Extrapolating the line to the 98 percent point yields a value of about 78 visits per year (i.e., 98 percent of the users visit less than 78 times per year). The calculated average for that range of number of visits is 39.5 (i.e., square root of 20 times 78 = 39.5).

The estimated total number of users is calculated for each class of frequency of visit. For example, the total number of users who visit between one and five times per year is 1,311 (i.e., 2,884 total visits divided by 2.2 visits per year). Thus, the estimated total number of users across all classes of frequency of visits is 2,266.

A less formal way of asking number of visits was given above with responses such as "less than once a year," "once a year," "several times a year," etc. Most of these responses imply an average rather than a range. Thus, once a year would be counted as 1; once a month — 12; twice a month — 24; etc. Several times a year would have an estimated average of 4.6 (i.e., square root of 2 times 11 assuming log-normality). Estimated total visits and total user are calculated in much the same manner as above.

Estimating the total number of users for each class of frequency of visits (i.e., stratum) is essential because one must use these numbers to weight the responses to each question that is relevant to users. Some questions on the visitor survey questionnaire will be relevant to visits and some will be relevant to users. For example, typical questions related to visits and users are as follows:

Visit-Related Questions

- What did you do on your visit to the information center today?
- Did you ask the staff for help finding the information and/or materials you were looking for?
- For what purpose did you need the information/ materials sought in the information center?
- Approximately when did you arrive at (or leave) the information center today?

User-Related Questions

- How satisfied are you with the ability of the information center staff to help you locate needed information and materials?
- How satisfied are you with the information center's collection of books and other materials
- What is your primary work role?

Some questions can be relevant to either visit or user depending on how the question was asked. For example:

- "How long does it normally take you to get to the information center?" is user-related.
- "How long did it take you to get to the information center on this visit?" is visit-related.

As indicated above, calculating measures from user-related questions is not straight-forward when made from a visitor survey. To demonstrate this, an example is given below for estimating the proportion of users who work in research and development (R&D) and other work roles. In this example there were 200 visitors who responded to the question concerning their work role (R&D and other).

Without weighting one would assume from the sample that 48.0 percent of the users are primarily engaged in R&D (i.e., 73 divided by 152 = 0.480). However, weighting by number of users in each stratum yields a much different result. Estimates in each stratum are calculated by taking he proportion of R&D and other professionals in each stratum and multiplying them times the number of users in the stratum. For example, the proportion of R&D professionals in the stratum of those who visit one to five times per year is estimated to be 0.321 (i.e., 9 divided by 28). Thus, the number in that stratum is 363 (i.e., 0.321 times 1,311) and the number of other professionals is 948 (i.e., 0.679 times 1,311). Considering all classes of number of visits, it is found that the weighted estimate of proportion of users who are R&D professionals is 32.9 percent (i.e., 746 divided by 2,266) compared with the 48.0 percent calculated from unweighted data. Actually, 48.0 percent is the proportion of visits that are by R&D professionals. In this example the weighted estimate is so different from unweighted results because R&D professionals tend to be frequent visitors (e.g., 18% visited more than 15 times), whereas other professionals tend to visit infrequently (e.g., 39 visited more than 15 times) Yet, the sample was even more pronounced (55% vs 16%).

The average number of visits by R&D and other professionals are 10.0 per person for R&D professionals and 5.5 visits per person for other professionals. These averages are calculated by multiplying average number of visits in each stratum times the total persons (e.g., 2.2 times 363), summing over the five strata and dividing by the total number in the population of interest (e.g., 746 R&D professionals). Note that the unweighted estimates would be 23.0 and 12.0 visits per person respectively, for R&D and other professionals. Thus, proper weighting substantially affects estimates of proportions and averages, as well as totals, thus avoiding biased or inaccurate estimates.

EXAMPLE OF ESTIMATES CONCERNING VISITORS FROM VISITOR SURVEY

	R&D			OTHER			BOTH	
NUMBER OF VISITS	SAMPLE	SAMPLE PROP. (%)	POP. TOTAL	SAMPLE	SAMPLE PROP. (%)	POP. TOTAL	SAMPLE	POP. TOTAL
1-5	9	32.1%	363	19	67.9%	948	28	1,311
6-10	11	28.2	147	28	71.8	37	39	522
11-15	13	40.6	105	19	59.4	153	32	258
16-20	8	72.7	46	3	27.3	17	11	63
More than 20	32	76.2	85	10	23.8	27	42	112
TOTAL	73	48.0%	746	79	52.0%	1,520	152	2,266

Chapter 9

Evaluating the Effectiveness of Specific Information Center Services

9.1 Background

In this chapter we discuss evaluation of several specific information center services from the perspective of users. This evaluation is different from the evaluation presented in Chapter 8 in that the evaluation in this chapter delves much more in-depth concerning satisfaction with service output attributes such as quality and timeliness, purpose of use of the service, and consequences of use of the service. Again, a user survey is the principal method used and a critical incident of a recent use of the service is the basis for much of the analysis. In particular we focus on the following services:

- online bibliographic and numeric database searching,
- *Current Awareness Bulletins,* and
- journal routing.

The basic philosophy of measures that we have discussed in other chapters holds here and would apply to other services as well. It is noted that performance of the operational aspects of the services above (i.e., input costs, output quantities and attributes, productivity, etc.) are covered in chapters found in Part 2. Measures of the value of these services and models relating linkage of output attributes to amount of use and consequence of use are covered in chapters in Part 4.

The sampling frame for surveys of specific services usually consists of lists of recent users of the services. This is true for in-house information centers and independent centers such as clearinghouses. We say recent because the survey will ask about a recent use of the service and some services such as online searching and access to article copies through document delivering services are relatively infrequent. Thus, recall or memory of the details of this last use will begin to dim after about three months. If there is no list of users, one can select the sample from a list of recent uses and apply the method described in Chapter 8 for estimating number of uses from samples of visitors. This is not a difficulty because most questions are use-related rather than user-related anyway. In fact, if the sample is of users it may be necessary to weight by uses as described in detail in the next chapter for document reading.

9.2 Online Bibliographic and Numeric Database Searching

In this survey we obtain data and information about the extent of online bibliographic and numeric database searching obtained from the information center and a series of questions concerns a critical incident of searching done by the center. The survey begins by acquainting the user with the fact that they have recently used the service. In our examples below we focus on online searching of external literature databases. A statement such as the following might be useful.

> You have been identified as a recent user of the Information Center Online Searching Services. These services include searching external literature databases (e.g., Dialog, BRS, ORBIT, CASOnline, etc.) online, and other sources for identifying and verifying needed documents. The questions below refer to your use of this service.

Q How many times have you or someone on your behalf used the Information Center for brief references or full-searches in the last year (i.e., 12 months)?

	No. of brief references last year	No. of full searches last year
a Used the service myself	____	____
b Asked colleague/subordinate to use the service for me	____	____

Note that we do not ask about use of alternative sources such as searching themselves, using a subordinate to do the searching themselves or using an external source (e.g., an academic library or broker). This information should be obtained from the General Population Survey in order to get unbiased results estimated from nonusers as well as users. Also, we ask respondents to indicate number of searches for a full year since there are usually relatively few uses of this service by one person over a year. Typically, more professionals use the service themselves rather than asking a colleague or subordinate to do so. Finally, brief reference searches tend to outnumber full searches by about two to one (say, five or six to two or three).

We then focus on a critical incident or the most recent search. Usually we concentrate on full searches, although it is not necessary.

> The questions below refer to your most recent use of Information Center Online Searching Services involving the last IN-DEPTH FULL SEARCH done for you.

Q What was the general topic for which this last in-depth full search was done for you?

Topic: _____

This question is largely asked to get respondents to focus on a specific search done for them.

Q On this last literature search, approximately how many documents or citations were identified, what proportion did you obtain, and what proportion did you (or do you intend) to read?

Type of item	Number identified	Proportion Obtained (%)	Proportion Read (%)
a. Journal articles	____	____	____
b. Books	____	____	____
c. External technical reports	____	____	____
d. Patent documents	____	____	____
e. Conference proceedings	____	____	____
f. Other (specify)	____	____	____

Averaged across searches, we find that journal articles tend to dominate responses with external technical reports following in number. Usually fewer than one-half of the citations are read.

The next set of questions deal with the performance and effectiveness of the service. It can be in a section labeled as such.

Q Did you discuss or negotiate the time it would take to perform the search with the searcher?

Yes 1
No 2

If yes, what was that duration of turn-around time?

_____ Hours or _____ Days or _____ Weeks

Surprisingly to us, we find that most information centers do not discuss or negotiate turn- around time with users, or at least users are not conscious that they do. Of course, in data analysis this time and the one below must be converted to a common time unit for analysis. Days seems to be the best unit.

Q From the time you initially contacted the Information Center to perform the in-depth full-search, how long did it take to receive the search results?

_____ Hours or _____ Days or _____ Weeks

This result should be compared with the negotiated time when appropriate.

Q How important was the response time for this last search?

	Circle one
Not at all important	1
Moderately important	2
Important	3
Very important	4
Extremely important	5

Q From the standpoint of response time of the search, were you:

	Circle one
Very dissatisfied	1
Dissatisfied	2
Neither satisfied nor dissatisfied	3
Satisfied	4
Very satisfied	5

Analysis of the response time (or difference in negotiated and response time), importance of response time and satisfaction with this output attribute provides a good picture concerning performance regarding this service attribute. Further discussion relating this and other attributes to extent of service use is given in Chapter 11.

Q To your best knowledge, was there any relevant information missed in this last search?

Yes	1
No	2
Don't Know	3

Most of the time users indicate "no" or "don't know". However, this question can be correlated with importance of and satisfaction with relevance of search output. These two questions are asked as follows:

Q How important is the relevance of information to your expressed needs for this last search?

	Circle one
Not at all important	1
Moderately important	2
Important	3
Very important	4
Extremely important	5

Q From the standpoint of the relevance of information to your expressed needs, were you:

	Circle one
Very dissatisfied	1
Dissatisfied	2
Neither satisfied nor dissatisfied	3
Satisfied	4
Very satisfied	5

The next questions deal with number of items or citations identified on the search. The actual number (given in a previous question) can be related to importance of and satisfaction with this service attribute.

Q How satisfied were you with the amount of information presented to you in the search output?

	Circle one
Very dissatisfied	1
Dissatisfied	2
Neither satisfied nor dissatisfied	3
Satisfied	4
Very satisfied	5

Q If dissatisfied, did you get too much or too little?

	Circle one
Too much	1
Too little	2

Typically, users get too little rather than too much, although in one organization the reverse was frequently true leading to a new policy.

Q How important is the amount of information presented to you in the search output?

	Circle one
Not at all important	1
Moderately important	2
Important	3
Very important	4
Extremely important	5

Some organizations charge for search service. However, even when they do charge users may not be aware of the amount due to charging policy. Nevertheless questions concerning user charges can be useful for evaluation.

Q Did you pay for this last in-depth full-search?

	Circle one
Yes	1
If yes, how much	$___
No	2
Don't Know	3

Q From the standpoint of the usefulness and value of the search, was the price:

	Circle one
Much too high	1
Too high	2
About right	3
Too low	4
Much too low for value received	5

Q How important was the price in your decision to use the search service?

	Circle one
Not at all important	1
Moderately important	2
Important	3
Very important	4
Extremely important	5

Finally in this section one might want to ask some questions about searcher competency from the perspective of users. This perspective is useful to compare with known competency and to correct if the user's perception is generally not valid. Note that another format for the question is given as an example.

Q From your perspective, how important is the searcher's skill in conducting the online research? Circle the appropriate rating.

Not at all important		Important		Very important
1	2	3	4	5

Q From your perspective, how well qualified was the searcher concerning knowledge of the subject field researched? Circle the appropriate rating.

Not at all qualified		Qualified		Very qualified
1	2	3	4	5

Q From your perspective, how important is the searcher's knowledge of the subject field searched? Circle the appropriate rating.

Not at all important		Important		Very important
1	2	3	4	5

Q How satisfied are you with the researcher's skill in searching?

	Circle one
Very dissatisfied	1
Dissatisfied	2
Neither satisfied nor dissatisfied	3
Satisfied	4
Very satisfied	5

Q How satisfied are you with the searcher's attitude?

	Circle one
Very dissatisfied	1
Dissatisfied	2
Neither satisfied nor dissatisfied	3
Satisfied	4
Very satisfied	5

Q Please feel free to comment on any aspects of the searcher's knowledge, skills, or attitude that you feel are important.

Q Please feel free to comment on any other aspect of the Information Center's Online Searching Service.

The final set of question's deal with the purposes and consequences of the Online Searching Service. These question's might be incorporated into a special section of the questionnaire These question's relate to (D, E, F and f on the framework Figure 4 in Chapter 2).

Q Please indicate the primary activity for which you used the results of this last search.

Activity	Circle only one
Research--basic or product development	1
Engineering-research or manufacturing/processing etc	2
Technical or research support (e q , QC, standards, consumer research, etc)	3
Management or executive	4
Administrative	5
Finance or accounting	6
Legal/Patent	7
Medical	8
Operations (e q , facilities engineering, mail serv. etc)	9
Background research	10
Professional development	11
Other (please specify)_____	12

Q Please indicate for which communications purposes this last search was primarily used.

Circle only one

Not done for communication purposes	1
Informal discussion with colleagues	2
Consulting or advising others	3
Making formal internal presentations	4
Making formal external presentations	5
Writing (reports, proposals, articles, etc.)	6
Other (please specify)_____	7

The pre-coded responses should correspond exactly to any other surveys that obtain information about primary work activities or communication activities (see Chapter 10). In this way results can be correlated or cross-checked. These questions particularly contribute to (D) on the framework in Figure 4.

Contribution to the professionals' work output attributes (F in the framework figure) is determined from the document reading survey (see Chapter 10). In that survey, respondents are asked about readings of documents that are identified by online searching; including the consequences of reading on quality, timeliness, etc. of the professionals' work. If that survey is not done (or responses are deemed too sparse to reveal the consequences of searching) then the user output attribute questions can be incorporated in this survey.

A series of questions may also be asked to determine one perspective of the value of the Online Search Service.

Q In what ways did you benefit by having a staff member from the Information Center perform this in-depth full-search for you?

Circle all applicable

I saved time for myself/staff	1
If so, approximately how many minutes or hours?	
_____ minutes or ____ hours	
They could perform the search faster than I could	2
They could perform the search better than I could	3
Other (please specify)_____	
_____	4

Q If Information Center could not have provided you with the in-depth full-search, how would you probably have done the search?

Circle any that you would have used

I would not have done the search	1
I would have done the search myself online	2
I would have done the search myself manually	3
I would have delegated the search to someone else on my staff	4
I would have used another, external library	5
I would have called a colleague who is knowledgeable in the subject field	6
I would have used a contractor/outside service	7
Other (specify)_____	
_____	8

Q How much time was spent by you or someone from your staff in obtaining the in-depth full-search? Approximately how much MORE would it have cost you to get it from the alternative source(s) you selected in the question above. If you cannot make a reasonable guess, please enter "DK" (Don't Know).

	Actual time	Additional time
Your own time (discussing search, etc)	___min.	___min.
Time of someone else on your staff (if you did or would ask them for assistance	___min.	___min
Fees associated with search services (if applicable)	$____	$____
Telephone calls	$____	$____
Other costs (please specify)_____		
_____	$____	$____

The first question provides an indication of the value of having the Online Search Service perform the search (f on the framework Figure 4).

The second question gives evidence of information that would be lost if there was no Online Search Service (typically about 20-30% of searches would not be done) and what alternate sources might be used (usually they would search themselves either manually or online).

The third question (1st column) indicates the amount of time that users spend with discussing the search, etc. and in other related costs. This indicates part of the "price" paid by users to use the Online Search Service. The question also determines how much more it would cost users to use alternative sources (2nd column). We consider this additional cost to be the most important indicator of the value of this service (see Chapter 13). Typically this value is two to four times the actual cost of the service.

9.3 Current Awareness Bulletin

Many organizations prepare (or purchase) Current Awareness Bulletins in order to keep users up-to-date with the current literature. In a sense these bulletins complement or replace purchase of personal subscriptions and/or journal routing. This service is quite expensive and, therefore, worthwhile evaluating from time to time to ensure that it is performing satisfactorily. The information center usually has a list of users and, therefore, a sampling frame is easily obtained. However, the General Population Survey may reveal that the bulletins are passed on to persons beyond the user list. If so a second stratum should be formed to complement the list of known users.

There are usually several bulletins published and distributed by the information center. Two questions help determine extent of use.

Q Do you currently receive a Current Awareness Bulletin issued by the Information Center?

Yes 1
No 2

Q Which Current Awareness Bulletins do you receive and approximately how often do you normally refer to a specific issue? Note that you may sometimes refer to a bulletin that you do not receive.

	Circle if you received the Bulletin issue	Average no. of times you refer to the Bulletin
Biosciences - Clinical Products Bulletin	1	____
Chemical Bulletin	2	____
Coating Line of Technology		
• Fluid section	3	____
• Vacuum/Magnetics/Optical section	4	____
Library Bulletins	5	____
Technical Report Bulletin	6	____

Note that use is for a single issue. Thus, total use must be projected to all issues (e.g., six) and from sample responses to number in the population surveyed.

The remaining questions deal with a critical incident of the most recent use of a bulletin.

Q What is the last Current Awareness Bulletin that you referred to?

Circle only one

Biosciences - Clinical Products Bulletin	1
Chemical Bulletin	2
Coating Line of Technology	
• Fluid section	3
• Vacuum/Magnetics/Optical section	4
Library Bulletins	5
Technical Report Bulletin	6

This question helps focus on the most recent use and also provides a cross-tabulation for evaluating specific bulletins.

Q Approximately how many issues back was that last Bulletin to which you referred?

Most recent one	1
Two	2
Three	3
Older	4
Don't know	5

Q For what reason did you refer to this last Bulletin?

Browsing most recent issue	1
Remembered a reference I needed	2
Other (specify)_____	3

These two questions help determine whether not the bulletins are used for retrospective searching (say, in lieu of online searching). There is little evidence from the studies we have done that bulletins are used in this way.

Q Approximately how much time did you spend reading or using this last Current Awareness Bulletin?

_____ Minutes

This question provides some indication of the "price" paid to use the bulletin and, therefore, is an indicator of it's value

Several questions correspond to the questions used for the Online Search Service in Section 9.2. Such questions include:

- data on number of items identified and read,
- purposes of use,
- importance of the bulletin, and
- comments about the service.

Other similar questions that are worded differently than the Online Search Service are as follows:

Q In what ways did you benefit by having the last Current Awareness Bulletin?

Circle all applicable

I saved time for myself or staff in identifying needed documents	1
• If so, approximately how many hours? ____ Hours	
Identified needed sources sooner than I could have otherwise	2
Identified needed sources that I probably would not have identified otherwise	3
Other (specify)_____	4

Q If the Current Awareness Bulletin was not provided to you, how would you have identified the needed sources? Select only the method you would most likely use.

Circle only one

I would not have done it	1
Department circulation/routing	2
I would have conducted an online search	3
I would have delegated an online search to someone else on my staff	4
Other (specify)_____	5

Q Approximately how much MORE would it cost you to use this other source?

Of my own time	____ hours
Time of someone else	____ hours
To purchase the search service	$____
Telephone calls	$____
Other (specify)_____	$____

Q Please rate your general level of satisfaction with the following attributes of the Current Awareness Bulletin you last used?

Very Dissatisfied	Dissatisfied	Neither Satisfied Nor Dissatisfied	Satisfied	Very Satisfied
1	2	3	4	5

	Satisfaction Rating (1-5)
Currency of items/entries identified in Current Awareness Bulletin	____
Coverage--neither too much nor too little	____
Quality of reproduction	____
Format of information in Current Awareness Bulletin	____
Items/entries given without an abstract	____
Ease of ordering Current Awareness Bulletin	____
Delay of receipt	____

For the last question it is useful to have respondents elaborate on attributes which are found to be unsatisfactory.

9.4 Journal Routing

We have found journal routing to work very well in some organizations and very poorly in others. A survey of journal routing can be done as part of a document reading survey (see Chapter 10) or independently. A survey concerning this service involves known users and possibly some users who receive copies from persons on the routed lists. Below are some questions that address evaluation of this service. Detailed results of the consequences of this service applies to questions from the document reading survey.

Q Do you receive circulated/routed journals?

Yes 1

• How many journals (not issues)? _____

No 2

Perhaps not too surprisingly, occasionally persons indicate they do not receive this service even though they are on a routing list. If the proportion who indicate "no" is high, some follow-up is warranted.

At this point a set of critical incident questions should be addressed concerning the respondent's last reading of a routed journal.

Q What position/number are you on this journal circulation/routing list? (e.g., 1st, 2nd, etc.)

Position/number _____

Q Approximately how long after the journal circulation/routing began did you receive it?

_____ Days or _____ Weeks or _____ Months

Q From the standpoint of time for the journal issue to get to you, were you:

	Circle one
Very Dissatisfied	1
Dissatisfied	2
Neither satisfied nor dissatisfied	3
Satisfied	4
Very satisfied	5

These questions together provide strong evidence concerning the appropriate number of persons who should be on a journal routing list. We find that six to eight persons is about the right number. Also, these questions help to identify trouble spots.

Q Approximately how many articles/items did you read from this journal issue and how many articles did you or someone on your behalf photocopy?

_____ articles/items read
_____ articles/items photocopied

This question provides the basis for estimating the total number of articles read as a result of using this service. By comparing cost per article read with other sources of journal articles (e.g., personal subscriptions, office collections, information center collection) we typically find that cost per reading is substantially less for this service. However, the length of routing lists must be kept short or satisfaction falls off rapidly.

On occasion we have examined the possibility of alternatives to current journal routing procedures. An example of a question concerning alternatives is given below.

Q There are some alternatives to journal routing or possible changes that could be made in the service. Please rank your preferences for five possible services from 1 (highest rank) to 5 (lowest rank).

	Rank (1 - 5)
a. Keep journal circulation/routing unchanged	____
b Keep journal circulation/routing lists short (by increasing number of copies purchased)	____
c Keep journal circulation/routing lists short by restricting routing list access to people with valid reasons for receiving the particular journal	____
d. Eliminate journal circulation/routing altogether, but maintain currency by keeping all new journal issues in a dedicated place in a nearby Information Center Site so they would be available to all users	____
e Replace journal circulation/routing with immediate mailing to individuals (electronic or paper) of the Tables of Contents of new journal issues These current issues would be available in a dedicated place in a nearby Information Center Site	____

Note that this question ranks alternatives, as opposed to rating them. The ranks can be averaged or displayed for each alternative, keeping journal circulation/routing lists short (by increasing number of copies purchased) is usually ranked highest.

Chapter 10

Evaluating the Higher Order Effects of Information & Information Service Use

10.1 Background

We refer back to the framework given in Chapter 2, Figure 4 and Figure 5. In particular, this chapter addresses (D), (E), (F) and (f) measures given in the framework in Figure 4. A survey is recommended that establishes time spent performing various activities (e.g., research, legal work, managing, finance, marketing, etc.). The survey also determines extent of communication input (e.g., quantities and time spent reading, listening, etc.), and output (e.g., quantities and time spent writing, advising others, making presentations, etc.) related to the work of professionals in an organization. Specific survey(s) are recommended for document reading regarding such information as depth of reading, how readers identified documents read, where they got the documents, and consequences of reading. Since information centers provide identification and access to many of the documents read, one can determine the extent to which centers contribute to the use, usefulness and value of information found in documents (i.e., D, E, F and f in the framework).

10.2 Information Input and Output

In order to determine amount of time spent by professionals doing their primary work and communicating one can ask three questions dealing with (1) total amount of time spent working in a year, (2) proportion of this time involved in various primary work activities (work roles), and (3) proportion of their time involved in communicating by various means. Examples of these three questions are given below. The first question deals with amount of time spent in work-related activities. Each organization has an accepted or scheduled amount of time. For example, in the U.S. a typical work year for professionals involves 2,080 hours with about 120 hours of vacation time, 88 hours of holidays and an average of about 52 hours of sick leave or 1,820 total hours. However, professionals often spend additional hours on work-related activities such as working late, reading while travelling to and from work, attending evening professional meetings, and so on. It is difficult and, perhaps not meaningful, to try to distinguish between regular hours and other time spent. Thus one can establish an organization's normal annual work hours (e.g., 1,820 hours) and add to that additional time by asking the following question.

Q Approximately how many hours *per year* do you devote to ORGANIZATION work or your own professional development that are *in addition* to the normal eight-hour work day? Include such time as working late (or early), reading while travelling to and from work, attending professional meetings during non-working hours, etc.

	Circle appropriate code
None	1
1-100	2
101-250	3
251-500	4
501-1,000	5
Over 1,000 (specify) _____hours	6

We find that average amount of such "over-time" ranges from 150—300 hours among organizations. A typical organization result is as follows:

	Proportion of Responses (%)
None	25 1%
1-100	13 3
101-250	71 6
251-500	18 4
501-1,000	13.1
Over 1,000 (average 1,234 hours)	8 3

For this company, average time is 296 hours per professional per year in addition to 1,820 for a total of 2,116 average total hours per professional per year. Average salary plus fringe benefits for this company is $52,500. Therefore, average hourly rate is $24.81 ($52,500 divided by 2,116). To that we often add about 50 percent for overhead (i.e., $37.22).

The second question deals with amount of time spent working on specific primary activities. This can be done by asking for the proportion of time spent (multiplied by total time spent determined from the question above). This question is asked as follows:

Q Please indicate the general kinds of activities that you perform in your work and the approximate proportion of time you spend over a year doing it, including time spent working for The Organization outside of normal working hours. Do not include vacation, holidays, sick leave, etc. in calculating proportions

Primary Activity	Never perform this activity (please circle)	Proportion of time spent (%)
Research-basic or product development	A	___%
Engineering-research or manufactu ng/ processing, etc	B	___
Technical or research support (e g , quality control, standards consumer research, etc)	C	___
Management or executive	D	___
Administration	E	___
Finance or accounting	F	___
Legal/patent	G	___
Medical	H	___
Operations (e g , facilities engineering, mail services, etc)	I	___
Background research	J	___
Professional development	K	___
Other (please specify)_____	L	___
All proportions entered must total 100%		100%

Since some types of professionals tend to work more time than others, one can establish estimated proportion of time for each activity by multiplying each proportion reported by total time (e.g , 1,820 + geometric means for reported amount) for each respondent, then add times across respondents for each activity to determine the total time for

that activity. The overall proportion for each activity is then a straightforward calculation.

Overall time spent communicating by various means is determined on the next question. In this question one can ask professionals to indicate the relative time they spend actually doing primary activities and how much time they spend communicating in various ways.

Q Above you indicated the primary activities in which you are engaged in your work. Now we would like to know how you spend your time actually doing these activities In particular we are concerned about the communication component of your work.

Please indicate the proportion of your time performing the activities above in actually thinking, conducting experiments, and so on and the time spent communicating in various ways.

Activity	Never perform this activity (please circle)	Proportion of time spent (%)
Actually doing the thinking, analysis, experiments, accounting,etc.	A	____
Informal discussions with colleagues	B	____
Consulting or advising others	C	____
Making formal internal presentations	D	____
Making formal external presentations	E	____
Attending formal internal presentations	F	____
Attending formal external presentations	G	____
Writing (reports, proposals, articles, etc)	H	____
Reading (reports, proposals, books, articles, etc)	I	____
Other (please specify)_____	J	____
All proportions must total 100%		100%

Referring to the schema depicting communication in organizations we have identified the amount of time devoted to *work input* involving:

	Proportion of total time (%)
• Interpersonal communication	
from internal sources	20%
from external sources	1
• Communication by documents	
from internal documents	3
from external documents	9

and work output:

• Interpersonal communication	
for internal recipients	19
for external recipients	4
• Communications by documents	
for internal recipients	7
for external recipients	03

Some quantities of information input are obtained in the questions below. Amount of reading (and time spent reading) is obtained in another questionnaire (Section 10.3 of this chapter).

Quantities of information output are observed from the following set of questions. The first question deals with amount of time spent consulting or giving substantive advice.

Q Approximately how many individual times did you consult or give substantive advice to others in the past month (30 days)?

_____ times in the past month

In this question we suggest using a month for the reporting time because we have found that those who say they consult or give substantive advice (typically 70% of professionals), do so rather frequently (typically 15—20 times per month or 200 times per year). Thus, we find that about 180 hours are spent giving substantive advice.

One can also partially measure output by the number of formal records written basically for internal use.

Q In the past year, how many formal records of your work (e.g., technical reports, laboratory notebooks, legal briefs, software programs, etc.) have you written or substantially contributed to?

	Sole Author	Co-Author	Contributor
Technical Reports	____	____	____
Laboratory Notebooks	____	____	____
Legal briefs	____	____	____
Other reports	____	____	____
Software programs	____	____	____
Other (please specify)	____	____	____

Here it is useful to establish the terminology used in the organization for reports. Some organizations have very formal definitions for different kinds of reports (e.g., technical memos, technical briefs, technical reports, etc.) An example of responses in an organization is given below.

	Proportion professionals who write (%)	Avg. no per professionals who write	Avg no per all professionals
Technical reports	____	____	2 3
Laboratory notebooks	____	____	1.0
Legal briefs	____	____	8 9
Other reports	____	____	9 8
Software programs	____	____	4 2
Other	____	____	7.8

As a guide we have found that reports average about three co-authors and two other contributors. Thus, total output quantities are adjusted by these factors. For example, if a person indicates they are a sole author of two reports and co-author of four, they are said to have written 3.33 reports.

We assume that books, formal articles and often similar publications are written largely for external consumption, although not entirely so. The extent to which these documents are written depends a great deal on the type of organization involved and the organization's policies. Few articles and books, for example, are written by company

authors Yet as shown above they spend an appreciable amount of time writing. Professionals at the National Institutes of Health in the U.S. spend even more time writing and almost exclusively for external consumption. An example of the question to obtain this information is given below.

Q In the past year how many external publications have you authored, co-authored or contributed to?

	Sole Author	Co-Author	Contributor
Accepted manuscripts of scholarly journal articles	____	____	____
Accepted and completed book manuscripts	____	____	____
Other publications (e.g., conference proceedings, chapters in books, etc.)	____	____	____

Journal articles average four to six co-authors. Books and other publications only average about 1.8 co-authors

One can obtain data about the number of internal presentations given as well as the time making presentations and attending presentations in the next question

Q In the past year, approximately how many formal presentations have you made (including shared presentations) concerning any of your work activities, average length of the meetings (in hours), and approximately how many total people attended all of these specific kinds of meetings?

Type of Meeting	Number of meetings	Avg. length of each meeting	Total no. of attendees at all meetings
a Informal worker's meetings	____	____	____
b Formal internal meetings	____	____	____
c Division meetings	____	____	____
d Other	____	____	____

In the example, one company reported averaging 9.9 formal internal meeting presentations, lasting an average of 1.9 hours with an average of 7.8 persons attending the meeting. This comes to an average of 18.8 hours making the presentations and 147 hours attending this kind of meeting In a sense, the amount of time spent attending the meetings is a "first order" indicator of the value of this information output. Because professionals' time is a scarce resource, their choosing to spend this time listening to the presentations is an indicator of the "price" (and, therefore value) they are willing to pay for the information. External presentations can be observed in much the same manner.

Q In the past year, approximately how many workshops, seminars, university classes/courses have you (or you with others) conducted or co-presented? (Count all individual classes of university courses.)

	Total number	Total hours	Total number of attendees
Internal	____	____	____
External	____	____	____
University/college	____	____	____

Finally, the number of written proposals and plans are obtained.

Q In the past year, approximately how many written proposals or plans did you prepare, how many have been accepted and how many are still pending?

Number of proposals, plans prepared . . . . . ____
Number partially accepted . . . . . ____
Number entirely accepted . . . . . ____
Number rejected . . . . . ____
Number pending . . . . . ____

One can ask about acceptance and rejection to obtain an indicator of the quality of the work.

The communication input resources and costs and output quantities are summarized for a typical organization in Tables 10.1 and 10.2.

10.3 Surveys of Document Reading and Use

We suggest that data be collected from one or more document reading surveys. Since most reading involves journals (scholarly and trade), books (business, scholarly, reference, etc.) and technical reports (internal and external) three separate document reading surveys may be warranted, although they can be combined into a single survey as is given in the examples below. These surveys should be from a population of users and potential users of an information center (e.g., all professionals in an organization). The examples below rely heavily on a critical incident of reading and, therefore, the survey is a pseudo two stage sample That is, the first stage sampling unit is people (e.g., professionals) and the second stage sampling unit is a specific reading, although usually only one such reading is observed Some questions involve the person sampled (e.g., amount of reading, amount of library use, and demographics), but most of the questions involve the reading (e.g., type of document read, how it was identified, where was it obtained, and consequences of the reading). Each type of question involves a different kind of estimation process which we will describe below.

The sample design required to sample individuals (i.e., 1st stage) should be essentially the same as described in the General User Survey (Chapter 8). Also most relevant information behavior and demographic questions discussed there apply in this kind of survey as well. It is useful, for example, to ask about number of visits and additional uses and similar questions on all surveys of the general population because they can be combined in a single database to increase the overall sample size for these highly relevant questions.

In order to weight or project the critical incident reading to the population total of readings for a year, it is necessary to obtain estimates of total readings by type of document read Later we will show how these numbers should be used. Since amount of reading is relatively frequent, we suggest using one month as a time period for observation. Just as with information center visits and other measures, one can ask this question in several ways One suggested way is as follows:

Q In the past month, approximately how many of each of the following types of documents have you read in connection with your work at The Organization. Reading is defined as going beyond the title, contents page, and abstract of the document.

TABLE 10.1
INFORMATION INPUT/RECEIVED

Type of Information	Internal Communications		External Communications	
	Hours	Quantities	Hours	Quantities
Recorded Information				
Reading books	—	—	61	19 books
Reading journals	—	—	65	101 articles
Reading external reports or patent documents	0	0	Unknown	21 reports or patent docs
Reading internal reports and memos	39	70 reports and memos	—	—
Total	39	94 readings	126	145 readings
Interpersonal Information				
Professional development	Unknown	Unknown	30	10 meetings attended
Formal presentations	128	49 meetings attended	—	—
Informal discussions	73	Unknown	—	—
Receiving consultation/advice	225	Unknown	—	—
Total	426	49	30	10
TOTAL	465	—	156	—

TABLE 10.2
INFORMATION OUTPUT/SENT

Type of Information	Internal Communications		External Communications	
	Hours	Quantities	Hours	Quantities
Recorded Information				
Writing reports	87		Unknown	Unknown
Technical reports/protocols		3 3 reports/protocols	Unknown	Unknown
Technical memoranda		6.6 technical memoranda	Unknown	Unknown
Standards/specifications		5 5 standards/spec	Unknown	Unknown
Original data (e g , lab notes, etc)		18.0 original data	Unknown	Unknown
Regular memoranda		46 9 memoranda	Unknown	Unknown
Writing proposals/plans	67	5 0 proposals/plans	Unknown	Unknown
Writing books	—	-	None reported	None reported
Writing articles	—	—	2	0 06 articles
Writing other publications	—	—	4	0.11 other pub
Writing patent applications	—	—	Unknown	0 08 patent applic.
Total	154	85 3	6	0 25
Interpersonal Information				
Consulting/Giving advice to others	225	258 occasions	Unknown	Unknown
Educating/Training others	59	1.6 sessions conducted	48	1 3 sess cond
Formal presentations	46	22.5 meetings conducted	42	7 5 mtg conducted
Informal discussions	73	Unknown	Unknown	Unknown
Total	403	282	90	8 8
TOTAL	557	—	96	—

No. of Readings/
Uses in Past Month

____ Professional journals or law reviews
____ Trade journals, bulletins, non-technical magazines, newsletters, etc
____ Professional, legal technical or business books
____ Reference books, handbooks, directories, manuals etc.
____ Standards and specifications
____ Proprietary information (technical reports, analytical methods, competitor analysis)
____ Laboratory notebooks (internal to the Company)
____ External reports (e g , government documents, patents, etc)

Respondents cannot recall exactly how many documents they have read, etc., but they have a good general idea. We have found our estimates to be close to estimates achieved using other, perhaps more accurate, methods. It is specified that respondents provide approximate answers because they will feel frustrated if they think exact values are required. Since approximations are adequate one can also ask the questions using ranges of number of readings such as:

	No of readings/uses in past month					
Type of document read	None	1, 2	3-5	6-10	Over 10	(specify) ___
Professional journals or law reviews	1	2	3	4	5	___

Calculations of average amount of reading can be done by using mid-points or geometric averages. For example, for one company results are as follows:

No. of Readings	Estimated Average	No of Responses	Proportion (%)
0	0	131	47.5
1	1	34	12.3
2	2	31	11.1
3-5	3 9	42	15
6-10	7 8	21	7 6
Over 10	20.9	17	6.2
		276	100 0

By cross-multiplying number of responses times estimated average (0×131+1×34+2×31+3.9×42+7.8×21+20.9×17) divided by 276 one gets an estimated average of 2.81 readings per month or 33.7 readings per year. One can make more refined estimates for projecting one month to a year as described in Chapter 8.

A series of questions concerning the critical incident of reading can then be asked. These questions help determine the proportion of readings that came from the information center, how the documents were identified, how thoroughly the documents were read and the consequences of reading. For each example question below we will indicate how the measure fits into the evaluation framework discussed in Chapter 2.

In the questionnaire there should be a section devoted to the critical incidents of reading. The section should have instructions that make it clear that answers refer to the critical incident. For example:

SECTION 2
DOCUMENT READING

All questions in this section refer to the document that you read most recently (related to your work or professional development). Please note that it does not matter how long ago this last document was read.

Q What type of document did you last read for work-related purposes?

Professional journals or law reviews 1
Trade journals, bulletins, non-technical magazines, newsletters, etc 2
Professional, legal, technical or business books 3
Reference books, handbooks, directories, manuals, etc. 4
Standards and specifications 5
Proprietary information (technical reports, analytical methods, competitor analysis) 6
Laboratory notebooks (internal to the Company) 7
External reports (e g., government documents, patents, etc) 8

We mention "work-related purposes" because we have found that respondents sometimes report non-work-related reading (particularly books) established from the next question. All the remaining responses are cross-tabulated and analyzed by type of document; sometimes into such groups as journals, books and technical reports.

Q What was the title or topic of this last read document? If the document was a journal article, refer to the article — not the journal title. Approximate document title or topic: _____

This question is asked primarily to make sure that the respondents focus on a specific incident. However, we have also found that general topics themselves have been useful for analysis in some instances.

Q If this last document read was a journal article, approximately how many articles did you read from the journal from which the article was read in the *last year* (12 months)? (SKIP IF THE LAST READ DOCUMENT WAS *NOT* AN ARTICLE)
_____articles

This question is used to analyze professionals' economic trade-off concerning use of personal subscriptions, journals in office collections and information center-provided journals. Depending on distance to the office collections and information centers, we find that professionals tend to use personal subscriptions when they read more than about 10 articles per year. This question is also used to estimate the total number of journals read by professionals, which is typically about 13 journals in which at least one article is read.

If a large number of professionals personally subscribe to journals in which they read fewer than 10 articles we recommend to them that they reconsider this decision and point out the economic benefit of using an information center to obtain infrequently used journals.

Q In what year was this document published (e.g., article written, etc.) ..... 19_____

This question provides an indication of the age distribution of documents read. Also, we find that most journal articles over two years old, for example, are read from journals provided by information centers. We generally recommend that individuals and office collections discard journal issues over two years old unless used very frequently.

Q Approximately how many previous times/occasions have you read or referred to this document?

_____ times/occasions

We correlate this response with method of identifying a journal article, book or report (see question below on how the respondent found out about the document).

Two questions give one an indication of how thoroughly documents are read.

Q How thoroughly did you read this document?

	Circle one code
With great care	1
With attention to the main points	2
Just to get the idea	3

Q What is your best estimate of the time in hours or minutes that you spent reading the document this most recent time?

_____Hours or _____Minutes

The time data are used (along with number of readings) to estimate the total time professionals spend reading. This is an indicator of the value they place on the information read. Also, we find that documents (particularly journal articles) provided by information centers are read in more depth and for a longer period of time than documents obtained from other sources. This result is not too surprising since most readings of journal articles read from personal subscriptions are recently published articles (typically 80% of the readings from articles published less than six months ago). These articles are not often read in depth, but rather mostly for current awareness.

These data are used to estimate amount of information used by professionals (D in Figure 4), amount of input resources (time) used to perform an activity (E in Figure 4), and proportion of the readings from documents obtained from information centers (f in Figure 4).

The next question deals with how professionals identified the document read.

Q How did you *initially* find out about this last document you read?

	Circle most appropriate code
If journal article only	
Found while browsing the journal issue:	
• of a circulated/routed journal	1
• of a personal subscription	2
• of an office collection journal	3
• of an information center journal	4
If book or technical report only	
Found while browsing the shelves of the information center	5
Found while browsing the catalogs of the information center	6
Recommended by information center staff	7
All documents	
From another person (e.g., a colleague, author, etc.)	8
Cited in another publication (i.e., article, book, etc.	9
Cited in the output of a computerized literature search	10
Cited in a print copy of a Current Awareness Bulletin	11
Cited in another printed index	12
Other (please specify)_____	13

This question (together with the one below) indicates the extent to which specific information center services contribute to reading (D, E, and f on Figure 4). The specific services include, for example, access to the collection, computer literature searches, *Current Awareness Bulletin,* journal routing, catalog, centralized purchasing of books, etc.

Q From which source did you get this last document that you read? Note that purchase of journal subscriptions include those journals obtained through professional society membership.

	Circle most appropriate code
A journal subscription or book that I paid for	1
A journal subscription, book or technical report that the Organization paid for (not information center)	2
A journal subscription, book or technical report that the information center purchased for me to keep (i.e., centralized ordering)	3
An information center copy ordered upon my request	4
A copy of a journal article obtained by the information center upon my request (from interlibrary loan or document delivery service)	5
A copy routed/circulated by the information center	6
A copy routed/circulated by someone else	7
An office collection	8
An external library (academic, public,etc.)	9
A colleague or co-worker	10
The author (not employed by the Organization)	11
Other (please specify)_____	12

Typically about 25 to 35 percent of articles, 25 to 50 percent of books and 30 to 60 percent of technical reports are obtained from information centers.

The next set of questions deals with the purposes and consequences of reading (D,E and F on Figure 4), and the contribution that the information center makes to reading (D, E, F and f). The first two questions follow the question concerning source of the document read. These two questions together are used to determine one perspective of value of the information center.

Q If you could not use the source specified above, where would you have obtained the document or equally useful information?

	Circle one code
Would not have obtained the document or information	1
From a colleague	2
From a consultant	3
From another library (please specify)_____	4
From my own collection	5
I would have bought it	6
Other (please specify)_____	7

Q How much time did you spend locating and acquiring the document? If you spent time, but don't know how much, indicate "DK." Enter your response in the First column. If you had to go to an alternative source for the document or information, approximately how much MORE time (than you actually spent) would you need to identify and acquire the document or information? Enter your response in the second column.

	ACTUAL time spent locating and acquiring (in minutes)	ADDITIONAL time using alternative (in minutes)
Of your own time to:		
a. Go to Information Center/ shared collection	___	___
b. Identify document	___	___
c. Locate document	___	___
d. Obtain document	___	___
e. Photocopy document	___	___
Of someone else's time if you asked or would ask some else to.		
f. Go to Information Center	___	___
g. Identify document	___	___
h. Locate document	___	___
i. Obtain document	___	___
j. Photocopy document	___	___
Other costs	(in dollars)	(in dollars)
k. Purchase document (e.g., user charge, subscription, etc.)	$___	$___
l. Photocopy document	$___	$___
m. Telephone calls	$___	$___
n. Other costs (please specify)_____	$___	$___

These questions are primarily analyzed for readings of documents obtained from the information center. The first question above indicates how much information would be lost if there was no information center and what alternative sources to it might be used. The second question (1st column) indicates the amount of time that professionals (and information center users) spend in identifying, locating and obtaining documents. This, added to time spent reading, is an indicator of the "price" paid for information found in documents (and, more specifically, documents obtained from the information center). This is one perspective of the value of information provided by information centers (i.e., a "willingness to pay" value). The second question (2nd column) determines how much *more* it would cost users to obtain information found in documents, in the absence of an information center. This we consider to be the principal estimate of the value of information centers. Another perspective of value is found from assuming that users spend a relatively fixed amount of time getting and using information. The second question shows how much additional time is required to get information, if there was no information center (see Chapter 13).

The General Population Survey provided estimates of the hourly rates of respondents (or they may be obtained in the demographics section of the Document Reading Survey). As a conservative estimate we assume that "someone else's" hourly rate is one-half that of users. About one-fourth of the respondents do not provide responses to the second question. One can impute directly for the column (i.e., actual time). This means that non-respondents are assumed to take the same time as respondents. For the additional time spent using alternative sources (column 2) one can use the response for alternative source as the basis for imputation. That is, calculate average time and costs for each of these alternative sources. If the respondent answers that question but not additional time, impute the appropriate average. Otherwise the overall average is used to impute. We find that average additional time is typically about 2 to 4 times higher than actual time spent locating and obtaining the documents.

It is useful to ask readers to indicate the purpose for which the document was read. The purpose is stated the same way as the primary work activity and communications activities found in the two questions soliciting how professionals spend their time at work.

Q For which primary activity have you used, or do you plan to use, the last document you read? Please indicate the *one principal activity* that is most descriptive.

	Circle one code
Research-basic or product development	1
Engineering-research or manufacturing/ processing, etc	2
Technical or research support (e.g., quality control, standards, consumer research, etc)	3
Management or executive	4
Administration	5
Finance or accounting	6
Legal/patent	7
Medical	8
Operations (e.g., facilities engineering, mail services, etc.)	9
Background research	10
Professional development	11
Other (please specify)_____	12

Q For which communications purposes (if any) have you used, or do you plan to use the last document you read?

Activity	Circle one code
Not read for communication purposes	1
Consulting or advising others	2
Making formal internal presentations	3
Making formal external presentations	4
Attending formal internal presentations	5
Attending formal external presentations	6
Writing (reports, proposals, articles, etc.)	7
Reading (reports, proposals, books, articles, etc)	8
Other (please specify)_____	9

These questions provide a classification for the contribution that reading and information centers make to professionals work (D and f in Figure 4).

Then one can "ask" questions that relate the professionals' output attributes (F in Figure 4) to amount of reading and source of documents (f in Figure 4). Prior to the series of questions, the respondent is referred to the first question above.

The questions below deal only with the principal activity given in QX above.

Q Did reading the document result in performing the activity with greater quality?

Yes	1
No	2
Don't know	3
Doesn't apply	4

Typically we find that there is indicated to be greater quality for about 40—60 percent of journal article readings, 70—80 percent of book readings and 60—75 percent of report readings. Documents obtained from information centers tend to have much higher proportions of readings of higher quality.

Sometimes we obtain an indicator of the extent of increase of quality by asking respondents to rate quality on a scale of one to seven before and after the document is read. The improvement in quality is typically 1.5 to 2.0 times the initial amount (found by dividing the average rating after by the average rating before).

Q Did reading the document result in your performing or completing the activity faster (in less duration of time)?

Yes	1
No	2
Don't know	3
Does not apply	4

Here we find much lower positive responses. Improved timeliness tends to result from about 20—30 percent of journal article readings, 40—50 percent of book readings, and 50—60 percent of report readings. Information center documents are again much more likely to be favorable.

The literature provides a number of anecdotes concerning how reading of information center materials results in large savings to readers. We have attempted to establish the extent to which such savings are achieved across all reading. This is done through a series of five questions. These questions relate to (E) in the framework Figure 4.

Q Did reading the document save you and/or your co-workers any labor time or other resources?

Yes	1
No	2
Don't know	3

We find that about 20—30 percent of the respondents reply that they do not know or don't respond at all. In order to be conservative in our estimates we normally classify these responses as "no". Generally, we find that about 25—35 percent of journal article readings, 40—70 percent of book readings and 50—75 percent of report readings result in such savings. Readings of information center documents are always higher, particularly for journal articles.

Q Which reason best describes how you saved (or will save) time or money by having read the last document?

	Circle all that apply
Avoided having to do some work	1
Provided confirmation of work in progress	2
Stopped an unproductive line of work	3
Modified an activity, project, etc	4
Initiated a new activity, project, etc	5
Other (please specify)_____	6

Avoiding having to do some work, modifying an activity or project, and providing confirmation of work in progress are the most frequently cited reasons (about 30—50% of readings in which there are savings) for savings.

Q Considering ONLY direct salaries, what is the approximate dollar value of the time you and/or your co-workers saved?

$ _____ total savings

Q How many co-workers were involved in the savings?

_____ co-workers

Q What, if any, were the dollar savings achieved for other things (such as equipment, supplies, avoided need for consultant, avoidance of regulatory penalties, etc.)?

$ _____ total other savings

Some respondents answer the earlier questions above, but not these latter questions. We normally impute average responses to these item nonresponses. However, one could impute based on the reasons for savings. The question of how many co-workers are involved is asked because, presumably each co-worker has a chance of answering the question. Thus, the estimated savings should be divided by the number of co-workers involved. We normally estimate average savings *for all readings,* not just those in which some savings are incurred. Savings from readings from information center documents are typically at least 50 percent higher than for documents obtained from other sources (especially journal articles).

One problem with interpreting these averages is that one tends to think of average as being "typical". The distribution of savings from journal article readings from one company is shown in the figure below. From the figure it is clear that about two percent of the readings contribute to nearly all the savings achieved.

Other beneficial consequences are also sought.

Q Please indicate any other benefits that you have derived from reading this document.

Circle all that apply

No other benefits that I can think of	1
Reinforced hypotheses or confidence in my work	2
Initiated ideas for my work	3
Helped guide future work	4
Broadened or narrowed options concerning my work	5
Provided needed market intelligence about competitor(s)	6
Used in lectures, seminars, etc	7
Other(specify)_____	8

Usually about ten to 25 percent of respondents can think of other benefits. "Helped guide future work" is the most frequent other benefit mentioned. However, all other benefits are frequently mentioned as well (20—40% of readings).

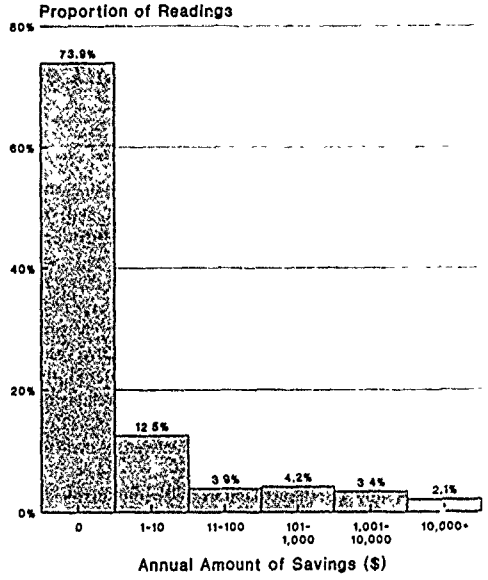
Finally, one can determine if the readers knew about the information reported or discussed in the document prior to their reading about it.

Q Did you know about the information reported or discussed in this document prior to reading about it?

Yes	1
No	2

The information found in journal articles is much less likely to be familiar to readers (25—50%), than for books and reports (50—80%).

Proportion of Journal Readings In Which Various Levels of Savings are Achieved



SOURCE: King Research, Inc.

Chapter 11

Relating Information Center Performance to Effectiveness

11.1 Background

In Chapter 3 we gave examples of several ways that one can express the relationship between input cost and output quantities and attributes. In this chapter we provide some examples for relating output attributes and service effectiveness. In particular, an example shows that amount of use is related to level of satisfaction with a service. A further example shows that some attributes have greater utility than others and that one can set a relative value on attributes. Since satisfaction with attributes is demonstrated to be important, we give an example which relates center input cost and satisfaction. Finally we give other examples of how one might relate cost to other effectiveness measures.

11.2 Relating User Satisfaction and Amount of Use of Services

An example is given below for online bibliographic search services. In the example we measure quality of searches by rating user satisfaction with (1) relevance of output to users' information needs and (2) number of references retrieved in search output. Timeliness is observed by the time between request and receipt of search results and it is measured by satisfaction ratings. The satisfaction ratings are from 1 (very dissatisfied) to 5 (very satisfied) An example of satisfaction ratings of these output attributes are given in Table 11.1. The results show that 2.2 percent of users are very dissatisfied with relevance of output to users' information needs and 30.8 percent of users are very satisfied. Average ratings across users surveyed is 4.15 or just above 4 (satisfied) for this organization, timeliness is rated highest in average satisfaction. The question becomes what effect satisfaction has on amount of use of services. Two approaches for examining this relationship are discussed below. The first approach involves correlating number *of* searches requested by users (per year) with level of satisfaction. Presumably users who are more satisfied will use the service more. The second approach is to use a conjoint measurement technique developed in the market research field. In that approach one can establish the relative importance of output attributes.

The best way to correlate user satisfaction and amount of use is to obtain both measures from a single survey instrument (see Part 3) One can calculate the average number of searches requested by those who are very satisfied, satisfied, etc. Below are examples for three search output attributes. For relevance of search output, those who are very satisfied search an average of 5.12 searches per year Those who are satisfied search an average of 3.71 and the average number of searches decreases as satisfaction decreases to 0 43 searches per year. Similar results are found for number of references in search output and timeliness as well. However, the severity of decreases in number of searches seems to be less than for relevance for the other two output attributes. Generally, we would conclude that quality is somewhat more important than timeliness. This assertion is confirmed in the example below.

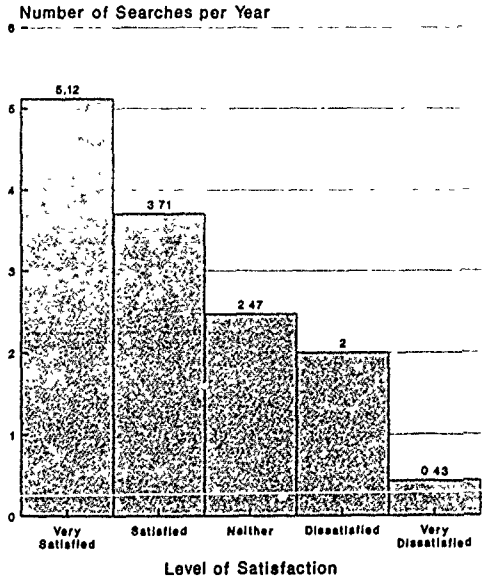
TABLE 11.1
EXAMPLE OF SATISFACTION RATINGS WITH ATTRIBUTES OF ONLINE BIBLIOGRAPHIC SEARCHES

Aspects of Online Bibliographic Searching	Satisfaction Level* 1 (%)	2 (%)	3 (%)	4 (%)	5 (%)	Average Satisfaction Level*
Relevance of output To Users' Information Needs	2 2	0 3	8 7	58 0	30 8	4 15
No of references in search output	1 9	2.9	11 4	54.7	29 1	4 06
Time between request and receipt of search output	1 7	0 6	5 6	40 6	51 5	4 40

SOURCE. King Research, Inc Survey of Professionals

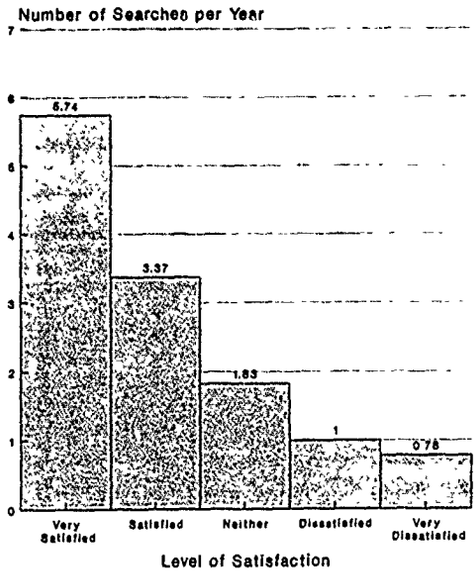
*Satisfaction Scale: 1 = Very Dissatisfied
2 = Dissatisfied
3 = Neither Satisfied nor Dissatisfied
4 = Satisfied
5 = Very Satisfied

Number of Searches per Year by Level of Satisfaction with Relevance of Output



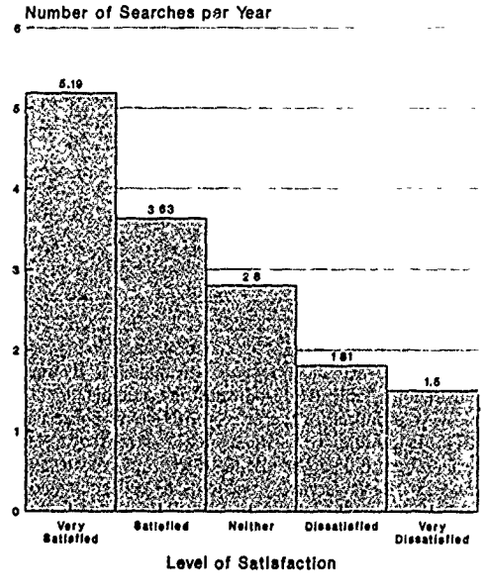
SOURCE: King Research, Inc.

Number of Searches per Year by Level of Satisfaction with Number of References in Search Output



SOURCE King Research, Inc.

Number of Searches per Year by Level of Satisfaction with Time Between Request and Receipt of Search Output



SOURCE: King Research, Inc.

The conjoint measurement method requires users of services such as online searching to make judgments about sets of alternatives involving different combinations of search output attributes: quality, timeliness and price. The output attribute of quality of search can be specified at three levels: high, medium and low relevance of times retrieved. Timeliness can also be specified to three levels: speed of response within a day, between one and three days and over three days. Price can be measured at three levels: $100, $150 and $250.

A potential model for assessing pricing of bibliographic products and services is conjoint measurement, which is used in marketing research, attempts to quantify the value systems of users. An example is adapted from Johnson[12]. Suppose that an online searcher has an option of paying more to achieve greater recall, fewer items retrieved, or faster response to searches. The conjoint measurement model relies on users' indicating their preferences for different prices at different levels of relevance, and response times. Conjoint measurement provides a relative utility measure of search attributes such as quality of search, speed of response, and price. Since it has been shown that the value of information center services is in saving time (a scarce resource), the respondent can think of the price paid in terms of their time as well as in user charges.

The mathematical method requires respondents to rank pairwise combinations of attributes using the questions below.

Q In the matrix below are two attributes: quality of search (i.e., high, medium and low relevance) and price ($100, $150, $250). Please rank the nine combinations of levels from 1 to 9. Presumably, the highest rank (1) is high relevance at a cost of only $100. The lowest rank (9) is low relevance at a cost to you of $250. Please rank the remaining cells from 2 to 8.

		Price	
Quality of Search	$100	$150	$250
High relevance of items	1		
Medium relevance of items			
Low relevance of items			9

Q In the matrix below, we give two other pairs of attributes: speed of response (within a day, within 3 days, over 3 days) and price. Please rank the unranked cells from 2 to 8.

		Price	
Speed of Response	$100	$150	$250
Within a Day . ..	1		
Within 3 days			
Over 3 days. . . .			9

Q In the matrix below, we give the last combination of pairs of attributes: quality of search and speed of response. Please rank the unranked cells from 2 to 8.

	QUALITY OF SEARCH		
Speed of Response	High Relevance	Medium Relevance	Low Relevance
Within a Day	1		
Within 3 days			
Over 3 days			9

Consider online searches differing only in price and speed of response and suppose a respondent were to state rank order of preference for online searches with nine combinations of price and speed of response. Such data could be arranged as follows:

	Price		
Speed of Response	$100	$150	$250
Within a Day	1	3	7
Within 3 days	2	4	8
Over 3 days	5	6	9

If these data were examined one attribute at a time, it would be concluded that this respondent prefers lower prices to higher prices and faster responses to slower responses, other things being equal. Although one can obtain such potentially valuable information by examining these one can see that although this respondent's preferred online search will require a $100 price and response within a day, his second choice shows that he would rather drop to a response time of within 3 days rather than pay the higher price of $150. Thus, by considering these two attributes jointly, one can learn something about their relative importance. To investigate this respondent's value system more generally, we could have the respondent express preferences for online searching differing in relevance and timeliness in relevance and price, and so on. If the user were very highly motivated, one could ask the user to provide tradeoff data for all possible pairs of attributes of interest.

A numerical example is given to show how conjoint measurement can be used to infer user values from pairwise tradeoff data. Suppose that online searching could be described adequately in terms of four attributes, each with three levels as shown above. Rank orders of preference data for an actual respondent are shown in Table 11.2, in which are shown six tradeoff matrices, one for each pair of attributes.

Consider a simple model of preference formation that assumes that each respondent has a positive utility value for each level of each attribute, and that the relative degree of liking for a specific online search is obtained by multiplying together his utilities for the attribute levels describing that online search. If a respondent's utilities are known for the relevant attributes, one could predict the user's rank order of preference for specific online search. A set of utilities for such a set of responses is provided in Table 11.3.

Relative liking for an online search of medium relevance with a price of $100 would be $.33 \times .51 = .1683$. This is a relative value, and it will have meaning only when compared with other similarly derived values for online searches having other levels of price and levels of relevance. For this person, high relevance and a price of $150 would have a relative value of $.57 \times .34 = .1938$. Therefore, this user would prefer the latter combination of price and relevance. In choosing among online search capabilities differing in all four attributes, the user's relative values would be obtained by computing the products of four utility values at a time rather than two at a time.

TABLE 11.2
ONE RESPONDENT'S TRADEOFF DATA (RANK ORDERS OF PREFERENCE)

	Average Response Time			Relevance			Average Items Retrieved		
	<5 sec.	6-15> sec	15 sec.	High	Medium	Low	<20	20-50	>50
Price									
$100	1	2	5	1	4	7	1	3	4
$150	3	4	6	2	5	8	2	5	6
$200	7	8	9	3	6	9	7	8	9
Top Speed of Response									
Within a day				1	3	7	1	2	5
Within 3 days				2	5	8	3	4	6
Over 3 days				4	6	9	7	8	9
Relevance (%)									
Low							1	4	5
Medium							2	6	7
High							3	8	9

TABLE 11.3
EXAMPLE CF ESTIMATED UTILITY VALUES FOR ONE RESPONDENT

	Level	Utility
Average Relevance	High Relevance	57
	Medium Relevance	33
	Low Relevance	10
Price	$100	51
	$150	34
	$250	15
Average Response Time	Within a day	31
	Within 3 days	42
	Over 3 days	27

Utilities are estimated so as to account simultaneously for all six of his pairwise tradeoff matrices in Table 11.2. By way of illustration, Table 11.4 indicates the computations of pairwise products for the price versus the response time. This user's utilities for the three price levels are shown at the top, and the utilities for the three levels of relevance are shown at the left margin. The value in each cell is obtained by multiplying together the utilities for that row and column. The rank orders of the numerical values in the cells of this table are indicated by the numbers in parentheses. It is found that these pairwise products have nearly the same rank order as the data themselves, the single exception being the cells ranked 6 and 7. Thus, the estimated utilities are quite consistent with the data and may be taken as a summary. These utility values are meaningful only in a relative sense. If one were to raise them to any positive exponent (such as squaring them or taking their square roots), their meaning would be unchanged. Further, since their absolute

magnitudes are arbitrary, they are scaled so that the sum for each attribute is unity.

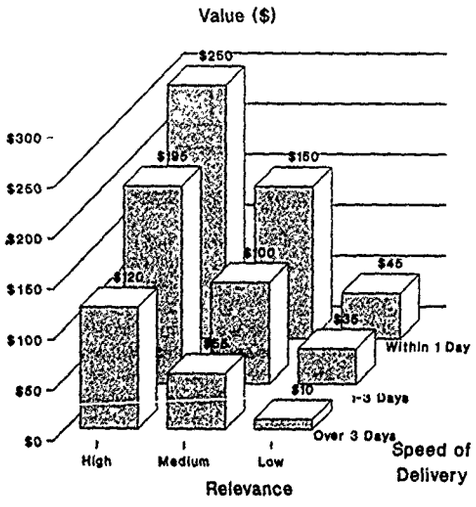
TABLE 11.4
PAIRWISE PRODUCTS OF UTILITIES

		Price		
		$100	$150	$250
Relevance		51	34	15
High	57	(1) 2907	(2) 1938	(5) 0855
Medium	33	(3) 1683	(4) 1122	(7) .1495
Low	10	(6) 0510	(8) .0340	(9) 0150

Although the model underlying this computation is a multiplicative one, it is not different in any important sense from additive models in more common use. By taking logarithms of these values, one could get new values for which sums rather than products would have the desired rank orders. Even considering the arbitrariness of scaling conventions, these particular utility values are not unique, other values obtained by slight modifications of them will still provide pairwise products having almost the same rank order as the data. However, if the respondent had reacted to several pairs involving each attribute and the respondent were to solve simultaneously for utilities best fitting all his preference data, there would probably be a unique solution apart from scaling.

The relative value of relevance and timeliness is also expressed in the figure below. This figure shows the monetary value of all nine combinations of levels of relevance and speed of delivery. If search results are returned within one day, but relevance of items retrieved drops from high to medium, the value decreases from $250 to $150. Similarly, if relevance remains high but response time drops from within one day to between one and three days, the value drops from $250 to $195. Thus, over all combinations of these two performance attributes, it is estimated that the value of quality is greater to the user than the speed of delivery, although both are appreciable. One can see that low relevance of items retrieved and response times of over three days reduce value to only an estimated $10. Clearly, both quality and timeliness of response should be kept at a high level when at all possible.

Relative Tradeoff in Value to User of Online Search Relevance and Turnaround Time



SOURCE: King Research, Inc.

11.3 Relationship of Search Time and Satisfaction

It is useful to know how much it costs to achieve high quality of online bibliographic searches One can evaluate this relationship of online bibliographic searches. One can evaluate this relationship by measuring search time (say, in minutes) and quality or user satisfaction. For an example we give ratings of user satisfaction with relevance of output as a measure of quality. Ratings of satisfaction are given numbers from 1 — very dissatisfied to 5 — very satisfied. In order to establish a valid relationship we must measure time and satisfaction ratings for the same searches. Time can be recorded by searches at the time a search is performed and users can be asked for their satisfaction rating on a search follow-up form or by contacting the user by mail or telephone. Hypothetical data are given in Table 11.5 for a sample of 50 online searches.

In the table the first search took 42 minutes and the user rated satisfaction with relevance of output at 3 (neither satisfied nor dissatisfied), the second search took 108 minutes and the user rated satisfaction as 5 (very satisfied), and so on The average time required per search is 71.9 minutes and the average satisfaction rating is 3.56 (i.e., about halfway between neither satisfied nor dissatisfied and satisfied, a generally low rating).

Below, search time is plotted against satisfaction ratings. In this example, satisfaction with relevance of output increases as more time is taken to search as one would expect.[1] However, the increase in satisfaction becomes smaller with increases in time. That is, increases in time of 20 minutes from 20—39 to 40—59 minutes shows an increase of 1.10 in satisfaction ratings (1.90 to 3.00), but increases in time of 20 minutes from 80—99 to 100—120 minutes shows an increase of only 0.40 in satisfaction ratings (4.30 to 4.70). One can also assign dollar values to the searches in terms of searchers' time, communication costs, hit rates, etc.

Searcher attributes can be examined as well. For example, suppose the 25 searches in the first two columns of Table 11.5 are done by searchers having subject knowledge (e.g., chemistry, engineering, law, etc.) or a great deal of experience and the other 25 searches are done by searchers with no subject expertise or little experience. The searchers with subject expertise average 67.4 minutes per search and experience average satisfaction ratings of 4.04. The searchers with no subject expertise average 76.4 minutes per

[1] In fact, real factors mitigate this relationship somewhat. For example, vaguely defined searches would require more time on the part of searchers, yet may even so result in relatively low satisfaction ratings.

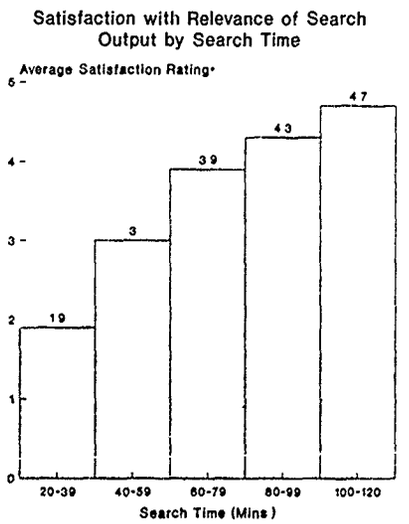
search and average satisfaction ratings of 3.08. Thus the first group of searchers is more productive and search with greater quality. More is said about this example in the last chapter. Also, this example is used in Chapter 7 to describe methods of calculating statistical standard errors and confidence intervals.

TABLE 11.5
EXAMPLES OF VALUES FOR DETERMINING RELATIONSHIPS BETWEEN TIME SPENT SEARCHING AND RATINGS OF SATISFACTION WITH RELEVANCE OF OUTPUT: 50 ONLINE SEARCHES

TIME (MINUTES)	SATISFACTION RATING	TIME (MINUTES)	SATISFACTION RATING
42	3	79	3
106	5	58	3
32	2	48	2
21	2	99	4
84	4	56	2
61	4	119	5
110	5	94	4
42	4	34	1
103	5	79	4
72	5	96	4
31	3	59	3
89	5	39	2
63	4	114	4
112	5	74	3
51	4	97	3
68	5	39	1
84	5	107	4
63	5	79	3
33	2	58	2
85	5	97	5
92	4	120	5
115	5	37	1
48	3	118	4

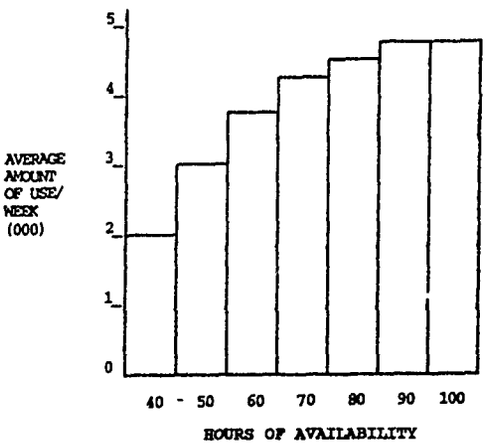
11.4 Examples of Relationships Involving Input Cost, Effectiveness, and Domain Measures

Below are a few examples where cost is related to certain output attributes or effectiveness measures. Some of the examples are from *Keys to Success*[4].



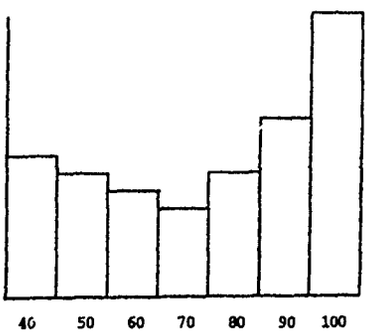
SOURCE: King Research, Inc.
*Satisfaction Ratings:
1 =Very Dissatisfied, 6 =Very Satisfied

The Amount of Use By Attribute Levels is an indicator of how the various attributes of output (quality, timeliness, availability, accessibility, etc.) affect the amount of use of a service or product. An example is the amount of use of online searching and output attributes (relevance, timeliness, etc.), discussed earlier. By also relating cost per use to levels of attributes a manager can predict the likely effects of changes in how much it will cost to achieve the desired levels of attributes



This example shows that amount of use (and average use) of a service goes up as the number of hours of availability of the service increases. Yet, in the example, increases in hours of availability up to a point do not increase amount of use very much.

EXAMPLE DISPLAY

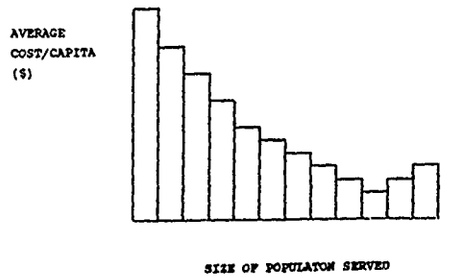


The above example displays cost per user across number of hours of availability of a service or the entire information center. In a previous example it was shown that total amount of use (and average amount of use) increases as hours of that total amount of use (and average amount of use) increases as hours of availability increase. Presumably the number of users also goes up with increased availability since, for example, some users may be able to visit the center and use its services only at odd times. It may be that average cost per use may decrease some as hours of availability increases up to a point and then increase rapidly because costs may be higher, say over a weekend or at night, and additional number of users may not be very high during weekends or at

night. Thus, cost per use might increase with increased hours of availability; for example, about 70 hours of availability. Regardless, this indicator suggests the value of increased hours of availability.

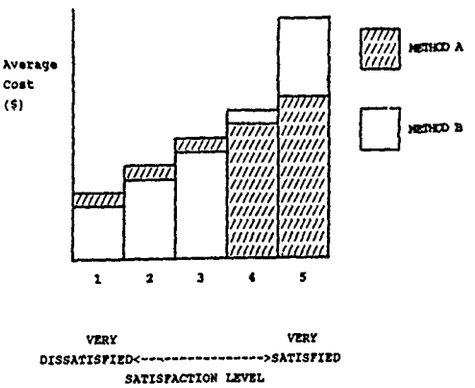
The Cost Per Capita relates the amount of funds (or other resources applied) to provide a service to the population served. The assumption underlying this indicator is that the higher the Cost Per Capita, the better the information center is performing (or the center's funders are performing). However, this comparison always assumes that the Cost Per Use remains constant across the libraries being compared; otherwise, the indicator could be negatively correlated with performance. It is seen as an indicator of the investment being made on behalf of the service population.

EXAMPLE DISPLAY



The Cost By Satisfaction Levels indicator relates the cost of resources to provide a service and the satisfaction of users with that service. It is similar to Cost By Attribute Levels, except from two different perspectives. Cost by Satisfaction Levels is useful in helping the library manager to understand the resource implications of improving the output of a service. For example, the indicator can be used to predict what resources would be necessary to increase satisfaction with quality of a service; similarly it can be used to predict the effect on satisfaction of changing the resources allocated to the service.

The relationship of this indicator to performance is negative in that the lower the cost the better the performance.



Average input costs by level of satisfaction is similar to Cost by Attribute Levels. Thus, another kind of display is given in this example. Here average cost is given for two methods of service provision, e.g., screened online search output and non-screened output, across levels of satisfaction. Cost of Method B is less than Method A at low levels of satisfaction but more at high levels of satisfaction. If high satisfaction is important, then Method A is superior, even though overall average costs could be greater for Method A

Chapter 12

Cost and Benefit Analysis of Information Center Service

12.1 Background

The raison d'etre of cost and benefit analysis is to assist in making decisions. Such decisions might be about an information center in its entirety, a function performed by the center, a service or product, an activity or even a resource. For example, decisions might concern whether to (1) hire a person (resource), (2) regularly screen output of online searches (activity), (3) employ an online cataloging system or a manual system (function), and the like. The answers to such decisions almost always involve comparisons of alternatives, and the costs and benefits of these alternatives are the bases upon which to make these comparisons. What we mean by comparisons is that a service, system, etc. being evaluated is compared with some alternative. For example, an online bibliographic search service would be compared with manual searching, searching by a broker or other such alternative. Comparisons would be made; with regard to input costs, output quantities (and attributes), effectiveness, and so on.

Costs and benefits should be described in terms of the unfavorable (i.e., costs) and favorable (i.e. benefits) results of the comparisons. For example, if an alternative to a search service is more expensive than the search service the comparison is favorable and, therefore, is a "benefit." If on the other hand, quality of the service is lower than an alternative, the comparison is unfavorable and, therefore, is a "cost." The term "cost" may be used in two ways. The most common use is in the application of resources in which cost could be the money associated with the resources The use of the term in this chapter would preferably be "detriment" which is the opposite of "benefit." However, convention has been to use the term "cost" rather than "detriment."

One can describe the results of comparison at all levels of input and output, and consequences such as effectiveness and higher order effects mentioned in previous chapters. If the comparison is unfavorable at any of these levels it is recorded in a cost column. If the comparison is favorable, it is recorded in a benefit column. The trade-off between cost and benefit can be made by comparing all the items in the cost column against the items in the benefit column. It is emphasized that comparisons of a service with alternatives can be described in any of the evaluation measures discussed thus far (e.g., dollar input costs, relevance of search output, satisfaction ratings, etc.). However, comparisons can also be in non-quantifiable terms as well such as, the equipment reliability is higher or lower or ease of use is better or worse. Thus, the results of each alternative can be described in terms of their costs (i.e., dollar amounts associated with resource expenditures and other quantifiable and non-quantifiable detriments that occur as well), and their benefits (i.e., dollar amounts associated with the favorable outcomes or consequences of choosing an alternative and other quantifiable or non-quantifiable benefits). Costs and benefits (of a resource, activity, service or product, function or the entire information center) are expressed in terms of input expenditures and other resources, and output in terms of quantities and attributes, effectiveness and higher order effects. However, costs and benefits are not measured as direct outcomes or consequences, but rather in terms of comparisons of resources, activities, and so on.

In summary, costs and benefits are measured by determining the unfavorable or favorable comparison of an alternative component, activity or service or product. This principle and some other concepts of cost and benefit are demonstrated through two examples; the first involving a resource (cataloger) and the second a service (online bibliographic searching). These examples are explored after reviewing some concepts of cost and benefits analysis.

12.2 Review of Some Cost and Benefit Concepts

To begin with, one must specify a period of time over which a cost and benefit analysis should apply. This time period should start at the present time and end at some specified time in the future, say, three or five years. With few exceptions, past costs (or benefits) should not be included in a comparison or analysis. Expenditures that have already been incurred are the results of past decisions and, therefore, unless such decisions are being evaluated retrospectively, they should not be considered. Relevant expenditures lie in the future, not in the past. Such past expenditures are often referred to as sunk costs. The question then is how far into the future should costs and benefits be considered. The answer to this question depends on how far into the future reasonable estimates can be made in light of such factors as inflation; expected amount of input, output and use; and the like. In information centers, a typical analysis period is three to five years into the future.

One of the critical aspects of deciding whether or not to incur an expenditure is to compare that expenditure against what else might be done with the money. In that sense, costs can be considered benefits foregone. A simple comparison would be to compare the benefits gained from investing in an automated system against the value of that money after five years if it were put into savings or an investment. The value of the money put into savings will increase by the compound interest (or return on investment) gained in the future, and will decrease by the loss of value as a result of inflation Usually, an equation that incorporates inflation and interest rates, thereby adjusting future costs and benefits to the current dollar value, is used. Such an analysis is referred to as present value analysis. It is particularly important because cost (and benefit) involves different kinds of expenditures including direct one-time fixed, direct recurring fixed and direct variable costs. Indirect costs such as administration costs might also be allocated to resources or activities. These concepts were discussed in Part 2.

It is important to remember that cost (and benefit) comparisons for each of these types of expenditures are

likely to be different. For example, if one is comparing an existing operational system against a potential alternative, the fixed cost of the existing system has already been incurred (i.e., it is a sunk cost) and should not being included in the comparison. If a new system is being considered (say, over a five-year planning period), the present value of fixed costs would be calculated over the entire five years. The first year recurring cost would be considered over five years, the second year recurring cost would be considered (at an inflated rate) over four years, and so on. Variable costs would change over years based on projected activity as well as projected inflation rates and interest rates.

Also, we find that the costs (and benefits) associated with the different categories of functions (i.e., library operational functions, user related functions and support functions) are somewhat different in that variable costs of operational functions involve quantities input or produced (e.g., interlibrary loans processed or searches performed) Support functions do not involve variable costs except in a very indirect way. By doubling the user related services, we may find that the cost of support functions may be less than, the same as, or more than double the costs. This results in the use of scaling factors which have been the subject of considerable analysis in recent years.

Indirect costs, such as those associated with support functions, may be allocated to the object of evaluation such as a service and an alternative to which it is compared. Such allocation usually is in proportion to the total direct costs involved.

Another aspect of costing involves those costs that one can attribute directly to a resource. A person or item of equipment can have several types of costs directly related to them. For example, an individual has a salary, fringe benefits, some furniture, work space and so on that can be included in the person's rates. With equipment such costs could be insurance, maintenance, space and so on. Also, there are indirect overhead items such as supervision and administration that probably ought to be allocated to the direct costs (see Chapter 4). These are indirect costs that are more difficult to determine how to handle in cost and benefit analysis. As a general rule, it is best to include as many direct costs as possible (i.e., fringe benefits, rent, etc.) and include indirect costs (i.e., overhead) only when such costs are unique to the operational level being considered, but not to an alternative to which it is going to be compared. If it is common to both, then it should not enter the cost and benefit analysis.

One final concept that one needs to understand is the difference between marginal costs, average costs and total costs. Total costs are the sum of one-time fixed, recurring and variable costs (of quantities input, output or uses). Average costs are the total costs divided by quantities input or output, or number of uses. Marginal costs are the costs of marginal changes whether they be of an additional item produced or in terms of changes in components, activities, services or products, or functions. Cost benefit analysis involves an assessment of the marginal changes. Benefits are maximized or costs are minimized only when the marginal ratios of benefits to costs are equal for all alternatives.

12.3 An Example of the Costs and Benefits of Catalogers

An example is given concerning how one can compute the costs and benefits of a resource (or activity, service, etc.) by comparing that resource to a realistic alternative. This will be done by an example of the hiring of a cataloger to do original cataloging. Assume that the decision at hand is to hire a specific professional with an MLS who will work full time at cataloging at a base salary of $20,000. Assume also that the person will stay in this position for three years with a salary and fringe benefit increase of six percent per year over that period of time Further, assume that the alternative is to hire an inexperienced person (non-MLS) at a base salary of $15,000, but who can be trained to catalog at a one-time cost of $5,000. Table 12.1 summarizes the costs and benefits associated with this decision.

In the first column we list the different levels at which costs and benefits of hiring the MLS over the alternative are measured In the second and third columns we list the measures or statements associated with each of the alternatives Finally in the last two columns we list the actual costs and perceived benefits of hiring the MLS over the alternative. Let us consider each level of measurement in turn below

The fixed one-time costs in this example are the training expenses. We assumed that the MLS would require training that would cost about $1,000 whereas the non-MLS would require considerable more training that would cost, say, $5,000. At this level the benefit of hiring the MLS over the non-MLS would be expressed as $4,000 since the expenses of the MLS are less than the expenses of the alternative by that amount.

The recurring cost estimates are derived from the base salary levels of the MLS and non-MLS. Their respective salaries ($20,000 and $15,000) are multiplied by a factor of 50 percent to take fringe benefits and overhead into account, so that these expenses become $30,000 and $22,500 per year, respectively. Because we initially set our planning period at three years, we need to determine how these expenses will change over those three years. Two factors are taken into account; inflation or salary increases and discounting for present value. This is done by multiplying by an inflation factor, say six percent and dividing by a discount factor, say, ten percent Numeric calculations are given as follows:

	Year 1	2	3
MLS	$30,000	30,000 x 1.06 / 1.1	30,0 2 x 1.06 x 1.06 / 1 1 x 1 1
Alternative	$22,500	22,500 x 1.06 / 1.1	22,500 x 1.06 x 1.06 / 1.1 x 1.1

The three year sum of the expenses for the cataloger with an MLS is $86,767 (i.e., $30,000 + $28,909 + $27,858) and the three year sum of expenses for the alternative is $65,075. The cataloger with an MLS would cost about $21,692 more over the three year planning period so that this difference would end up in the cost column.

Cataloger Characteristics

At this level we made the assumption that hiring a person with an MLS over an inexperienced non-MLS would give

TABLE 12.1
SUMMARY OF COSTS AND BENEFITS ASSOCIATED WITH THE DECISION OF WHETHER TO HIRE A CATALOGER WITH AN MLS DEGREE

Levels of Measures	Person Being Hired	Alternative	Costs	Benefits
Expenditures				
Fixed one-time	$ 1,000/Training	$ 5,000/Training		$4,000
Fixed Recurring	$30,000/Year	$22,500/Year	$21,692	
Characteristics	MLS	BS		Better competencies (knowledge, skills, attitudes)
Effectiveness				
Quality	95% Accuracy	85% Accuracy		10% more accuracy
Quantities Produced	2,250 items/yr.	1,500 items/yr.		2,250 more items produced (i.e., 750 per + $32,538 year)
Higher Order Effects				Better user satisfaction; more use; increase value to organization
SUM			$21,692	$36,538 + 10% more accuracy + better user satisfaction + more use + increased value to organization

the center the benefit of greater cataloging competencies (knowledge, skills, attitudes).

The assumption we made for this example concerning quantities produced were that the MLS could do original cataloging at a rate of about 1.25 items per hour (i.e., 2,250 items per year, assuming an 1,800 hour year, and the non-MLS only 1,500 per year). Once again, we need to consider these levels of activity and their associated expenses over each of the three years of the defined planning period. The alternative cataloger approach would require another person one-half time to do the original cataloging performed by the cataloger with an MLS. The cost over the three year planning period of doing this would be $32,538 ($11,250 + $10,841 + $10,447). Thus, one of the benefits of having an MLS cataloger do the original cataloging would be $32,538 savings on expenses.

Higher Order Effects

At higher levels we assume that better cataloging competency and better cataloging performance result in higher user satisfaction which, in turn, results in more use of the library. In turn, we have shown in Chapter 13 that greater use of information yields greater value.

In summary, the net benefit of hiring the MLS over the non-MLS is $14,846 plus 10 percent more accuracy, more items cataloged per cataloger, greater user satisfaction and more use of the center. All decision alternatives can be evaluated using this cost and benefit balance-sheet approach.

12.4 An Example of the Costs and Benefits of Online Bibliographic Searching Services

In this example (from a company) we look at the cost and benefit of an online bibliographic search service that does

about 4,500 in-depth searches per year. Users are asked what alternatives they would use if the information center could not provide the search. The search would not be done for about 19 percent of the searches. For the searches that would be done, the users said that 38 percent of the searches would be done by them manually, 19 percent done by themselves online or by someone else on the staff (8%), 14 percent would have asked another information center to do it, 15 percent would have called a colleague who is knowledgeable in the field, or 6 percent would have a contractor/outside service to do it. The costs and benefits of the online service are determined by comparing the service with these alternatives regarding service expenditures (i.e., service input cost), service output, effectiveness and higher order effects. Results of these comparisons and costs and benefits are given on Table 12.2.

The expenditures (input costs) include fixed recurring costs for terminals, search aids, searcher training and continuing education, telephones, and rent. These expenditures amount to about $17,000. Reference materials come to another $9,000. Variable costs include communication charges, database use, off-line printing and list rates and searchers' time. This amounts to about $47.50 per search or about $214,000 total. All of these expenditures are recorded in the cost column. Output as indicated is 4,500 searches. However, users said that about 855 (19%) of the searches would not be done as an alternative to the service. The 855 is recorded in the benefits column. The users also said in a survey that 92 percent of the searches done by the center's service would be done better by the service (than an alternative), 85 percent would be done faster and 87 percent resulted in saving time of the users. These results are placed in the benefits column.

Users were also asked to indicate: "How much time was spent by you or someone form your staff in the in-depth search?" and "Approximately how much more time would it

TABLE 12.2
SUMMARY OF COSTS AND BENEFITS OF ONLINE BIBLIOGRAPHIC SEARCH SERVICES

Levels of Measure	Online Search	Least Expensive Alternative	The Cost or Benefit of Online Service	
			Costs	Benefits
Expenditures				
Fixed	$ 17,000	0	$ 17,000	
Reference materials	$ 9,000	0	$ 9,000	
Variable	$ 214,000	0	$214,000	
Output				
Quantities	4,500 searches	3,645		855 more searches
Quality				92% better
Timeliness				85% faster
Other				87% saved time
Effectiveness				
User's time	$ 170,000	$ 760,000		$ 590,000
Other labor	$ 12,000	$ 92,000		$ 80,000
Other	$ 52,000	$ 482,000		$ 430,000
Higher Order Effects				
Items read	80,000	64,900		215,100 readings
Consequences	$5,530,000	$4,480,000		$1,050,000
SUM			$240,000	$2,150,000 92% of researches better, 85% of searches faster, 87% saved time, 15,100 more readings

have cost you to get the search from alternative sources?" (that they specified earlier in the questionnaire). It turns out that users currently spend about $234,000 on searches (users' time, other labor and other costs) and $1,330,000 using alternative sources to the center. Thus, we record savings of $590,000 in users' time ($131 per search), $80,000 in other labor ($18 per search) and $430,000 in other expenditures such as search fees, telephone calls, etc. Thus, their total benefits came to about $ 1.1 million (compared with center costs of $240,000) or a 4.6 to 1 ratio.

Higher order effects result from readings from the search outputs that are lost because users would not do 855 of the searches. We do not know what the consequences are of poorer and less timely alternative searches. Users indicated that they read (or intend to read) about 17.8 items per search. Thus, the users read about 80,000 items as a result of the 4,500 searches. They would lose about 15,100 items read (i.e., 19% of the searches that would not be done). We have found that the value of those readings is about $69 per reading (see Chapter 13.4). Therefore, approximately $1,050,000 might be lost in value from these readings. This amount is recorded in the benefits column.

The sum of costs and benefits are given in the table. Costs come to about $240,000 and benefits are $1.1 million for direct effectiveness, $1.0 million or potential higher order effects, 855 more searches done, 92 percent of them done better than alternatives, 85 percent done faster and 87 percent of the searches saved time of the users.

Chapter 13

The Value of Information Centers

13.1 Background

In this chapter, we explore ways to assess the value of information centers. Below, we briefly discuss the rationale that we have used in assessing value of services. In particular, value is assessed from three perspectives: what users are willing to pay, how much more it would cost users to get information if the services were not available, and the extent to which the services achieve cost savings for the users. Then we analyze the value of the information centers in providing journals, books and internal reports. We also assess the value of online bibliographic searching and Current Awareness Bulletins, since they are particularly important services. The value of information centers is found to be substantial, regardless of the perspective from which the evaluation is performed.

13.2 Value of Information Center Collection

There are three levels that are considered in assessing the contribution that an information center makes to the value of information. Information centers are not inexpensive. Typically, organizations spend an average of between $500 and $1,500 per professional in their organization. On behalf of the organization, the center pays for expensive journals, books and other materials. Acquiring, processing, maintaining and distributing these materials in a timely way is very labor-intensive. Furthermore, information centers provide a range of other services such as reference, online searching, translation, and so on. There needs to be a clear demonstration of a favorable return on this investment.

The first question that comes to mind is whether the price paid for center materials and services has a concomitant value. The lowest bound for assessing this value is from the perspective of the readers. What are they willing to pay for this information? One can readily measure what they do pay, recognizing that they might pay more if they had to. Time of professionals is a scarce resource. Professionals must decide how to utilize their time in order to be most productive. Engineers, scientists, lawyers, administrators, and so on, devote a substantial amount of their time to getting, reading and using information found in documents such as journals, books, internal documents, patents, and so on. Their decision to use their scarce time for information seeking and reading is a strong indication of the value they place on information. The total time (and the dollar amount represented by this time) spent on information provided by an information center is an indicator of the value of the center. In organizations, this value tends to be on the order of several times that of the cost to the information centers in purchasing and providing these materials.

Of course, the information could be obtained by the professionals from other sources. They could subscribe to journals or purchase books themselves. Then they would lose potential savings achieved by sharing these materials. They could use another source, such as an academic library, but that involves substantial professional time required to identify, locate and get access to these other sources. They could order materials from document delivery services, publishers or elsewhere, but that assumes an ability of professionals to identify needed information then locate where it is and acquire it. Furthermore, if all professionals relied on academic, public or other libraries, these libraries would soon stop making their collections available because of the enormous cost and possible denial of access to their own primary patrons. In fact, this trend has already begun at some academic institutions in the U.S. The point is that having a nearby library in the parent organizations saves their professionals considerable time and money.

About two-thirds of the cost savings achieved by information centers involves professional time. We have observed, over the years, that professionals tend to spend a relatively constant proportion of their time in getting and reading information. The amount of time they spend may shift from accessing to reading or vice versa, but the total seems not to vary much. With this in mind, we developed a rationale for determining what would happen if professionals had to rely entirely on non-information center sources (i.e., if there were no center). We assume that there would be less reading because more time would be required for identifying, locating and acquiring information from other sources. Therefore, the potential benefits derived from readings that are lost would not be achieved. Such benefits, include savings (in time, equipment, etc.) derived from information and improvements in quality of work, timeliness of work output, and so on. Such lost benefits are what we consider the highest order of value of the information center services. This value, compared with the cost of centers, is substantial. The savings alone are typically found to be on the order of 10 to 20 times the total cost of the center services.

Determining the extent to which services contribute to the value of information is achieved using the following rationale:

- The number of readings that are made from materials provided by the information center is first determined.
- The amount of time that the professionals spend in identifying, locating, obtaining accessing and reading the materials provided by the center is estimated. This is what the professionals are "willing to pay" for these materials.
- Then assume that center services are not available to the professionals. If they are not available, the professionals would have to get their journals, books, etc. from alternative sources such as personally subscribing, using other office collections, going to an external library, contacting a colleague to get materials, and so on. Even assuming the least expensive and time-consuming alternative, we find that professionals must spend more of their time getting access to the information and that additional costs are involved as well.

- The additional amount of time and other costs required by professionals is estimated. This is the second level of the value of the information center.
- It is assumed that professionals spend a given amount of time in information seeking and reading. Because they would have to spend more time if center services were not available, they would read less and, therefore, lose savings, timeliness, quality, productivity, etc., resulting from lost readings.
- The dollar savings, quality, timeliness, productivity, etc., that are lost by not having the center available are considered to be the third type of value of these services.

13.3 The Value of Journal Articles Provided by Information Centers

In this example, professionals from the organization surveyed are estimated to read about 600,000 journal articles per year. About 196,000 of these readings are from journals provided by the information center (from copies located at the center, journal routing, etc).

The approximate professional time required for identifying, gaining access to and reading journal articles obtained from the center is estimated as given in Table 13.1 for all article readings from the center journal copies.

TABLE 13.1
AMOUNT OF TIME SPENT PER YEAR IN IDENTIFYING, LOCATING, OBTAINING AND PHOTOCOPYING JOURNAL ARTICLES OBTAINED FROM INFORMATION CENTER BY ORGANIZATION PROFESSIONALS

Activity	Avg. Time Per Reading (minutes)	Total Amount of Time per Year (000 hours)
Professional's Time		
Going to center	3.7	12.2
Identify article	1.4	4.6
Locate article	3.4	11.2
Obtain article	0 2	2.6
Photograph article	2.4	7.9
Total	11.7	38.5
Someone Else's Time		
Going to center	2.1	6.9
Identify article	1.4	4.6
Locate article	1.4	4.6
Obtain article	1.3	4.3
Photograph article	0.8	2.6
Total	7.0	23.0

SOURCE: King Research, Inc. Survey of Professionals

The estimated total amount of time professionals spend identifying and gaining access to journal articles provided by the information center is about 38,500 hours per year or about 11.7 minutes (0.195 hours) per article read. Adding to that the amount of time spent reading (0.7 hours for journal readings from center copies), it is estimated that the total time spent is about 175,700 hours per year or $6.7 million for the professionals (assuming an average hourly wage of $38.13). Adding to that the costs of the time of others and other costs ($2.20 and $0.80 per article read or a total of $538,000) yields a total of $7.3 million.

The average current cost of these readings of journals provided by the center is $37.20. This is the minimum that professionals are "willing to pay" for these materials and, as such, the amount is a lower bound on the value of journal articles provided by the center. Typical average additional costs to the center of purchasing and processing subscriptions and conducting online searches are estimated to be about $12.00 per reading. Thus, the ratio of center costs ($12.00) to this value of information ($37.20) is about three to one.

There are two ways that we have studied the methods and costs of obtaining journal articles from alternative sources (i.e., other than the center). The first involves observing from national surveys which explore how scientists and engineers get their articles when they have no library available (e.g., when they are employed by small businesses). We determined the approximate amount of time spent identifying, locating and getting information from the other sources. For the second method, we also asked professionals to indicate (1) how they would obtain the information (not necessarily the journal article, if another source such as a colleague or consultant was less expensive) from the least expensive alternative, and (2) how much additional costs (above the current cost) would be required in terms of: (1) their time; (2) the time of others (e.g., secretary, technician, etc.); and (3) other costs, such as subscription to a journal, etc.

The process began by determining whether the professionals knew about the information reported (or discussed) in the most recent article read, prior to their reading about it. About 68 percent of the readings involved new information. The readers were asked how they would get the articles, if the information center could not be used. About four percent of the professionals said they would not obtain the article or information. Of the readings in which the information was not new, the information would most frequently be obtained from a colleague or other source.

The average additional costs (i.e., how much more it would cost over current costs) of using the least expensive alternative source for journal articles (if the center were not available) are summarized as given in Table 13.2.

The average cost to professionals for the alternative sources of journal article readings is $75.60 per reading (including current costs plus additional cost of the alternative). This average cost of alternative sources includes the following components of cost:

	Avg. Current Costs	Avg. Costs of Alternatives	Avg. Difference ($)
Professionals time	$34.20	$64.00	$30.70
Time of others	$ 2.20	$12.40	$10.20
Other costs	$ 0.80	$ 1.10	$ 0.30
Total	$37.20	$78 40	$41.20

TABLE 13.2
AMOUNT OF ADDITIONAL TIME IT WOULD TAKE IN IDENTIFYING LOCATING, OBTAINING AND PHOTOCOPYING JOURNAL ARTICLES IF ORGANIZATION PROFESSIONALS DID NOT HAVE AN INFORMATION CENTER

Activity	Avg. Time Per Reading (minutes)	Total Amount of Time Per Year (000 hours)
Professional's Time		
Going to center	28.3	92 4
Identify article	8.3	27.1
Locate article	6 3	8.2
Obtain article	4.2	13 4
Photograph article	1.1	3.6
Total	48.2	157.5
Someone Else's Time		
Going to center	9.1	29.7
Identify article	12.1	39 5
Locate article	5.4	17.6
Obtain article	4.2	13.7
Photograph article	1.1	3.6
Total	31.9	104.2

SOURCE: King Research, Inc. Survey of Professionals

The total cost of alternative sources to the information center is about $8.1 million (i.e., $41.20 times 196,000 readings of journal articles provided by the center). This amount is the second estimate of the value of the information center.

A third way to look at the value of the center in providing access to journals is to consider that professionals seem to spend a relatively fixed amount of time in information seeking and reading (based on national data collected by us and others over 25 years). If we assume that this is true for professionals in this example, they would have less time for this activity (i.e., obtaining and reading articles) if the center were not available (or did not exist). The total time the professionals spend identifying, gaining access to and reading journal articles (accessed though the center service) is 175,500 hours. The additional time necessary to obtain articles previously provided by the center (if the services were not available) is about 157,500 hours, thus a new average time per article read is 1.7 hours per reading (i.e , 333,000 hours divided by 196,000 readings). Dividing this into the constant hours devoted by professionals to this activity (175,500 hours) yields 103,200 readings. Therefore, about 92,800 readings would be lost to professionals (i.e., 196,000 minus 103,200) Assume average loss in savings attributable to reading journal articles is $450 or 11.8 professional hours per reading. Total loss would be $842 million or 1.1 million hours of professional time. Thus, their productivity would be affected. In addition to lost savings in time the lost readings would also have some effect on quality, timeliness and other work performance factors as well.

13.4 The Value of Books Provided by the Information Center

Professionals in the example organization have 520,000 readings from books per year of which 124,000 of these readings are from books provided by the center. The approximate amount of professional time spent reading books provided by the center is estimated to be about 1.7 hours spent reading and 0.35 hours spent identifying, locating and getting the books (Table 13.3)

TABLE 13.3
AMOUNT OF TIME SPENT IN IDENTIFYING, LOCATING, OBTAINING AND PHOTOCOPYING BOOKS OBTAINED FROM THE INFORMATION CENTER BY ORGANIZATION PROFESSIONALS

Activity	Avg. Time Per Reading (minutes)	Total Amount of Time (000 hours)
Professional's Time		
Going to center	8.1	16.7
Identify book	3.6	7.4
Locate book	3 1	6.4
Obtain book	2.1	4 3
Photography book	3 9	8 1
Total	20.8	43.0
Someone Else's Time		
Going to center	4.0	8.3
Identify book	1.8	3 7
Locate book	1.2	2.5
Obtain book	1.1	2.3
Photography book	1.7	3 5
Total	9 8	20 3

SOURCE: King Research, Inc. Survey of Professionals

The total time spent by professionals on identifying and accessing the center-provided books is about 43,300 hours. The total time, including reading, is about 253,800 hours. The amount professionals pay in terms of their own time getting access to and reading books is about $9.7 million (i.e., the minimum value to them).

About 75 percent of the readings of books provided by the center involved books containing information whose existence was known prior to reading. About 72 percent of the time the respondents indicated the information could have been obtained elsewhere, such as from an external library (30%), a colleague, consultant, etc., (26%), they would have bought it (12%) or the professionals' own collection (4%). Even though professionals know about the information most of the time, the cost of locating and acquiring it is expensive. These costs are summarized as follows in Table 13.4.

The ave "ge cost per reading books currently obtained through the center and by using alternatives is as follows:

	Avg. Current Costs	Avg. Costs of Alternatives	Avg Difference ($)
Professionals time	$ 78.40	$103.50	$25.10
Time of others	$ 3 10	$ 10 50	$ 7.40
Other costs	$ 15.60	$ 18 70	$ 3.10
Total	$ 97.10	$132.70	$35 60

Thus, the total cost of alternatives to the information center is $4.4 million, (i.e., 124,000 times $35.60).

TABLE 13.4
AMOUNT OF ADDITIONAL TIME IT WOULD TAKE IN IDENTIFYING, LOCATING, OBTAINING AND PHOTOCOPYING BOOKS IF ORGANIZATION PROFESSIONALS DID NOT HAVE THE INFORMATION

Activity	Avg. Time Per Reading (minutes)	Total Amount of Time per Year (000 hours)
Professional's Time		
Going to center	17.2	35 5
Identify book	5.8	12.0
Locate book	6.4	13 2
Obtain book	5 2	10.7
Photograph book	4.8	9.9
Total	39 4	81.4
Someone Else's Time		
Going to center	11 5	23 8
Identify book	2 9	6 0
Locate book	3 0	6 2
Obtain book	2 9	6 0
Photograph book	2.9	6.0
Total	23.2	47.9

SOURCE: King Research, Inc. Survey of Professionals

Finally, the additional costs to professionals (in their time) for obtaining the book-related information are about 81,400 hours, or a new total of about 338,200 hours for 124,000 readings. Taking this additional cost into account results in a new average hours per reading (2.7 hours per reading). In order to maintain a constant total 256,800 hours, the number of readings would be 95,100 instead of 124,000 readings. Therefore, 28,900 readings would be lost. The value of these lost readings represents the potential savings in time and equipment (i.e., $690 or 18.1 hours of professional time per reading) as well as improved quality and timeliness of work that would have been achieved. Converted to professional time, this comes to about 523,100 hours. The total value calculated in this manner is $20 million (i.e., 28,900 readings that are lost times $690 in savings per reading).

13.5 The Value of Internal Documents Provided by The Information Center

Professionals read about 360,000 internal documents of which 158,000 are through documents obtained at the information center. The professionals are estimated to spend an average of about 1.0 hour (per reading) in reading internal documents and 0.31 hour in identifying, locating and getting the documents to read. The latter estimates are subdivided as shown in Table 13.5.

TABLE 13.5
AMOUNT OF TIME SPENT IN IDENTIFYING, LOCATING, OBTAINING AND PHOTOCOPYING INTERNAL DOCUMENTS OBTAINED FROM THE INFORMATION CENTER BY ORGANIZATION PROFESSIONALS

Activity	Avg. Time Per Reading (minutes)	Total Amount of Time per Year (000 hours)
Professional's Time		
Going to center	4 3	11 3
Identify internal documents	4 4	11 6
Locate internal documents	1.5	4 0
Obtain internal documents	7.9	20 8
Photograph internal documents	0 7	1.8
Total	18 8	49 5
Someone Else's Time		
Going to center	2.8	7 4
Identify internal documents	1 6	4 2
Locate internal documents	1.7	4 5
Obtain internal documents	2 0	5 3
Photograph internal documents	0.9	2.4
Total	9 0	23 8

SOURCE: King Research, Inc Survey of Professionals

The estimated total time spent by professionals in identifying, locating, obtaining and reading documents provided by the center is 207,000 hours (i.e., 158,000 readings times 1.31 hours per reading). Thus, the "willingness to pay" value is $7.9 million.

The information found in read internal documents was known by the readers for 53 percent of the readings. They indicated that some would not have obtained the document or information, if the center was not available (2.4%). Most of them would get it from a colleague (47%), an alternate library (23%) or elsewhere (5%).

The average additional costs of obtaining internal documents or information found in them from alternative sources to the center are given in Table 13.6.

The average cost for using alternative sources is $12.00 per reading as shown below.

	Avg. Current Costs	Avg. Costs of Alternatives	Avg Difference ($)
Professionals time	$50.10	$60 30	$10 20
Time of others	$ 2.90	$ 4.20	$ 1.30
Other costs	$ 0 90	$ 1.40	$ 0 50
Total	$53 90	$65 90	$12.00

The total cost of using alternatives for the 158,000 readings of internal documents is $1.9 million.

A total of 42,000 hours of additional professionals' time would be involved in using alternative sources. Thus, a total of 249,000 hours would be required to obtain and read 158,000 documents — or 1.58 hours per reading. If the professionals continue to spend 207,000 hours with these documents, they would be able to read 131,000 at 1.58 hours per reading. This means they would lose about 27,000 readings. Savings for these 27,000 readings is estimated to be $1,210 a piece (on the average) or a total of $33 million. In terms of professionals' time this value is 850,000 hours.

TABLE 13.6
AMOUNT OF ADDITIONAL TIME IT WOULD TAKE IN IDENTIFYING LOCATING, OBTAINING AND PHOTOCOPYING INTERNAL DOCUMENTS IF ORGANIZATION PROFESSIONALS DID NOT HAVE THE INFORMATION CENTER

Activity	Avg. Time Per Reading (minutes)	Total Amount of Time per Year (000 hours)
Professional's Time		
Going to center	7.0	18.4
Identify internal documents	1.6	4.2
Locate internal documents	3.4	9.0
Obtain internal documents	2.6	6.8
Photograph internal documents	1.4	3.7
Total	16.0	42.1
Someone Else's Time		
Going to center		
Identify internal documents	1.2	3.2
Locate internal documents	1.2	3.2
Obtain internal documents	1.2	3.2
Photograph internal documents	0.5	1.3
Total	4.1	10.9

SOURCE. King Research, Inc Survey of Professionals

13.6 Value of Other Services

The value of searches performed by the information center staff is how much more it would cost to do the searches if there were no center staff available to search. We find that about 19 percent of the searches would not have been done. Over four-fifths of the searches would have been delegated to someone else on the professional's staff; 12 percent would have been obtained from an external library; and 20 percent, called a knowledgeable colleague or used a contractor or online service. The cost of using alternative means of searching is estimated to be about $240 *more* than is currently spent on the searches (about $110). Most of this additional cost is in terms of the users' time ($59), but some of it is in the additional cost to purchase a search ($21), someone else's time ($8) or other expense ($22). Thus all told, it would cost the organization about $1.1 million more to conduct the searches without the benefit of the center staff.

The users of Current Awareness Bulletins indicated a number of ways in which they benefitted by having the last Current Awareness Bulletin as follows:

- Identified needed sources that they probably would not have identified otherwise 58%
- Identified needed sources sooner than they could have otherwise 29%
- Saved them or their staff time in identifying needed documents 21%

They indicated it would require an average of about 3.4 hours of their time or their staffs' time to identify needed documents themselves.

If the Current Awareness Bulletin was not provided to the professionals, the users would have identified the needed sources in the following manner:

- They could not have done it 59%
- Department circulation/routing 17%
- They would have conducted an online search 9%
- They would have delegated an online record 8%
- Other means 8%

The cost of using the other source is estimated to be about $57 per use of the Bulletins. This cost of alternative sources is derived from:

- Using their own time $34.00
- Using the time of others $12.00
- Cost of purchasing a search service $10.60
- Telephone calls and other $ 0.30

13.7 Total Value of The Information Center

As indicated above, the value of the information center services can be assessed from three perspectives: what users are willing to pay (in terms of their time and effort) for information provided by the center, what it would cost them to use alternative sources for obtaining the information, and what savings (or research cost avoidance) would be lost if the center did not exist. Rough estimates for these three perspectives of value are given below.

The return-on-information of this cost is substantial, regardless of how one views value. That is, the return is:

- 4.3 to one in terms of willingness to pay,
- 2.5 to one in terms of cost to use alternative sources, and
- 15 to one in terms of research cost avoidance (savings)

These returns are impressive indeed.

TABLE 13.7
THE VALUE OF INFORMATION CENTER SERVICES
FROM THREE PERSPECTIVES
AND BY SOURCE OF READING

	Willingness to Pay	Cost to Use Alternative Sources	Cost Avoidance by Savings
Journals	$ 7.3 million	$8.1 million	$42 million
Books	$ 9.7 million	$4.4 million	$20 million
Internal documents	$ 7.9 million	$1.9 million	$33 million
Online searching	$ 1.5 million	$1.1 million	—
Current Awareness Bulletins	$ 0.2 million	$0.7 million	—
Total	$26.6 million	$15.3 million	$ 95 million

SOURCE: King Research, Inc.

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