Measuring Service Quality in the Networked Environment: Approaches and Considerations

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ABSTRACT

THE NETWORKED ENVIRONMENT OFFERS LIBRARIES challenges and opportunities in a number of areas including management, service provision, and collection development. A particular challenge that libraries face in the networked environment is that of measuring and evaluating network-based services. This article offers a number of statistics and performance measures that libraries may find useful in determining the overall quality of their network-based services; identifies a number of service quality criteria; and provides a framework to assist librarians in selecting statistics and performance measures based on service quality criteria. The statistics and performance measures, criteria, and framework are the result of a number of current and past research projects conducted by the author and others across library types.

INTRODUCTION

The development of library networked statistics and performance measures is an important undertaking that is receiving increased attention and support. There is a great need for statistics and performance measures that:

- assist libraries to make a strong case for support for a technology and information infrastructure by documenting their Internet-based services and resources;

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- allow libraries to effectively compare themselves to others in terms of Internet development, costs, provision of services, connectivity, and use;
- enable library directors and administrative library agencies to compete for resources with other organizations and/or departments by documenting the range, extent, and impact of library-provided networked services;
- facilitate the transition from traditional library use measures such as circulation, reference transactions, interlibrary loans, and so on, to network measures that describe the nature and use of library-based network activities and resources;
- provide a decision-making framework for library staff, managers, and administrators to determine resource allocation strategies and meet other management needs; and
- provide the means to measure the quality of library services and resources in the networked environment.

These and other factors point to the overall importance for research that generates library network statistics and performance measures.

METHODOLOGY

This article draws upon findings from a number of research efforts:

- Institute of Museum and Library Services National Leadership Grant to develop national public library network statistics and performance measures (January 1999-August 2000). The study used a multi-method approach to the development of national network statistics and performance measures (see Figure 1). The data-collection efforts encompassed a variety of data-collection activities that involve library researchers, practitioners, policy makers, state library agencies, database vendors, and public library administrators and staff. In particular, the study team worked with six states throughout the data-collection process (Delaware, Maryland, Michigan, North Carolina, Pennsylvania, and Utah) to develop, test, and finalize the network statistics and performance measures (see Figures 2 and 3). Additional study findings, statistics, and performance measure collection, management, and evaluation techniques are available in Bertot, McClure, and Ryan (2001).
- Evaluating the statewide electronic networks of the state libraries of Delaware (DelAWARE, http://www.lib.de.us/) and Maryland (Sailor, http://www.sailor.lib.md.us/), as well as the state library of California's InFoPeople project (http://www.infopeople.org/) (1996-1999). The Sailor and DelAWARE evaluation projects focused on assessing and measuring the networked environment for statewide networks, while the InFoPeople evaluation project centered on the

Qualitative

Technique	Function/Purpose
Case Sites	In-depth exploration of selected communities and target audiences in those communities, use of, and involvement with, the network. Use findings to inform broader quantitative data-collection activities such as mail and electronic surveys.
Content Analysis	Gather various documentation and reports to review historical development, evolution of network-related activities, and future directions.
Critical Path Analysis	In-depth exploration of user-based interactions with project-related components (e.g., training, workstation use, and searching). Use findings to uncover specific instance issues. Particularly appropriate for in-depth analysis of training and use issues.
Focus Groups	Explore identified key issue areas of network content, services, management, and performance. Use findings to inform broader quantitative data-collection activities such as mail and electronic surveys.
Policy Analysis	Systematic review of policy instruments (e.g., legislation, regulations, standard operating procedures, governance documents) to assess scope, formation, implementation, execution, and impact of network policies. Use findings to develop context of network activities, identify key governance issues, and develop recommendations for future network policy development.
Small Group and Individual Interviews	In-depth exploration of network content, services, management, and performance with key project administrators and users. Assess the relationship between components of the network and future educational use and development of network resources. Use findings to inform broader quantitative data-collection activities such as mail and electronic surveys.

Figure 1. Methodologies for Measuring Electronic Networked Services.

Quantitative

Technique	Function/Purpose
Mail/Electronic Surveys	Further explore identified key issue areas of network content, services, management, and performance with broader project population. Test findings from qualitative data-collection activities with broader network population.
Pop-up Surveys	Web-based surveys triggered by access to a particular portion of a Web site. Focused exploration of section of Web site.
Network Traffic Measures	Collect network/terminal traffic use statistics such as users, user access points, information and service content use, and network server and router load. Provides sense of network load, capacity, and what services are used and with what frequency.
Web Log File Analysis	Measure Web-based services by the analysis of Web server log files. Provides sense of users and locations which access the services, server traffic, type of technology users have, and errors encountered.

Figure 1. Methodologies for Measuring Electronic Networked Services.

Network Statistic	Definition
Public Access Workstations	
Number of public access workstations	Annual count of the number of library-owned public access graphical workstations that connect to the Internet for a dedicated purpose (to access an OPAC or specific database) or multiple purposes.
Number of public access workstation users	Annual count of the number of users of all library graphical public access workstations connected to the Internet computed from a one-week sample.
Maximum speed of public access Internet workstations	Indication of the maximum bandwidth of public Internet access, e.g., less than 56kbps, 56kbps, 128kbps, 1.5mbps, etc.
Databases	
Number of full-text titles available by subscription Report: Serial titles, Other titles, Total titles	Count of the number of full-text titles that the library subscribes and offers to the public computed one time annually.
Number of database sessions	Total count of the number of sessions (logins) initiated to the online databases. Definition adapted from proposed ICOLC standard http://www.library.yale.edu/consortia/webstats.html.
Number of database queries/searches	Total count of the number of searches conducted in the library's online databases. Subsequent activities by users (e.g., browsing, printing) are not considered part of the search process. Definition adapted from proposed ICOLC standard http://www.library.yale.edu/consortia/webstats.html.
Number of items examined using subscription services	Count the number of views to each entire host to which the library subscribes. A view is defined as the number of full text articles/pages, abstracts, citations, and text only, text/graphics viewed. Definition adapted from proposed ICOLC standard http://www.library.yale.edu/consortia/webstats.html.

Figure 2. Public Library Network Resources and Services Statistics *(Continued on p. 763).*

Network Statistic	Definition
Electronic Services	
Number of virtual reference transactions	Annual count of the number of reference transactions using the Internet. A transaction must include a question received electronically (e.g., via e-mail, WWW form, etc.) and responded to electronically (e.g., e-mail).
Public service time spent servicing information technology Report: Information technology staff, Paid public service staff (Professional Librarian, Paraprofessional), Volunteer, & Total	Annual count of the staff hours spent in servicing information technology resource and service activity in public service areas computed based on a one-week sample.
Virtual Visits	
Number of virtual visits to networked library resources Report: Number of internal virtual visits, Number of external virtual visits, Number of total virtual visits	Count of visits to the library via the Internet. A *visit* occurs when an external user connects to a networked library resource for any length of time or purpose (regardless of the number of pages or elements viewed). Examples of a networked library resource include a library OPAC or a library Web page. In the case of a user visit to a library Web site, a user who looks at 16 pages and 54 graphic images registers one visit on the Web server.
Instruction	
User information technology instruction Report: Number of users instructed, Number of hours of instruction	A count of the number of users instructed and the hours of instruction offered in the use of information technology or resources obtainable using information technology in structured, informal, and electronically delivered instruction sessions conducted or sponsored by the library.
Staff information technology instruction Report: Number of staff instructed, Number of hours of staff instruction	Annual count of the total number of staff instructed and the number of hours of formal instruction in the management or use of information technology or resources obtainable using IT.

Figure 2. Public Library Network Resources and Services Statistics.

Public access Internet workstations in proportion to the legal service area population	The ratio of the *legal service area population* to the number of *public access Internet workstations.* E.g., XYZ library provides 1 public access Internet workstation per 3,000 legal service population.
Average annual use per public access Internet workstation	The ratio of the number of *public access Internet workstation users* to the number of *public access Internet workstations.*
Total reference activity	Combine traditional measures of reference service with electronic measures.
Percentage of virtual reference to total reference questions	Percentage of the number of *virtual reference transactions* to total reference questions (both traditional and virtual).
User information technology instruction as percentage of total reference activity	The number of *users instructed in information technology* as a percent of *total reference activity.*
Level of paid public service effort in servicing information technology	Percentage of paid public service staff time spent serving the public that is spent servicing information technology during a sample period.
Total library materials use	This composite measure combines the circulation and use figures for all of the paper; multimedia, and electronic collections that the public library owns or provides access to.
Percentage of electronic materials use of total library materials use	Compares electronic materials use in the form of the number of *items examined using subscription services* with the *total library materials use.*
Total number of serial titles offered	Count of paper based serials titles added to the number of *full-text serial titles available by subscription*
Percentage of serial titles offered in electronic form	Compares the number of *unique electronic full-text serial titles available by subscription* to the *Total number of serial titles offered.*
Total library visits	Physical attendance at the library and the number of *virtual visits* combined into one total.
Percentage of remote library visits	The percent of virtual visits to total library visits (virtual plus physical library visits).
Percentage of legal service area population receiving information technology instruction	The percentage of the *legal service area population* receiving information technology instruction annually from the public library.
Hours of formal information technology instruction per staff member	The average number of hours of formal information technology instruction a public library staff member receives per year.
Number of users of electronic resources and services	This composite figure adds the number of *virtual visits to networked library resources,* the number of *users instructed in information technology* and the number of *virtual reference transactions.*

Figure 3. Public Library Network Composite and Performance Measures.

impact of Internet connectivity on public libraries (Bertot, McClure, & Ryan, 1999; Bertot & McClure, 1996, 1999a).
- National studies assessing public library involvement with, and use of, the Internet conducted between 1994 and 2000. These studies focused on public library-based Internet and technology infrastructure, issues, and use (Bertot & McClure, 1999b, 2000).
- In-progress research sponsored by the Association of Research Libraries (ARL) to develop network statistics and performance measures for academic libraries (see http://www.arl.org/stats/newmeas/emetrics/index.html).

Together, these studies provide substantial findings that inform the network statistics and performance measures and quality measurement framework presented in this article.

The types of data-collection techniques used in the above mentioned studies included:

- case studies/site visits to various libraries, state library agencies, and other appropriate organizations;
- interviews and focus groups with key stakeholders in libraries, state and local government, library professional organization staff members and relevant working committees, state library data coordinators, and others; and
- national and statewide mail and Web-based surveys.

The methods were used generally in some combination and employed an iterative learning strategy in which the data-collection activities were sequenced so that the findings from one data-collection event were incorporated into subsequent data-collection activities. This technique of iterative learning allowed for the refinement, modification, and adaptation of data-collection approaches as the studies progressed.

The study teams involved in the various research efforts engaged in a number of activities to ensure reliable and valid findings as described in Krueger (1994), Creswell (1994), and Babbie (1997). Additional information on the methodologies for each study is available in the study reports.

Developing a Model for Measuring Service Quality in the Networked Environment

There are a number of approaches in developing a quality measurement framework for networked library services and resources. Thus, while this article presents one quality framework, others are possible. Indeed, Bertot et al. (2000) identify at least four models for determining library network statistics and performance measures:

1. Audience Model, in which the consumer of the network data is the primary lens for developing network statistics and measures;

2. Technology Infrastructure Model, in which the existing information technology (IT) architecture and/or equipment drives the types of statistics and measures in which a library is most interested and finds most useful;
3. Network Component Model, in which various network service and resource dimensions are measured along a number of service quality indicators; and
4. Composite Model, in which aspects of the various models are incorporated into a service quality approach.

Each model presents a different lens for developing statistics and performance measures and has both strengths and weaknesses. The Network Component Model, however, offers a more robust approach to developing network statistics and performance measures as well as providing a service quality framework.

The Network Component Model

As first described by Bertot and McClure (1998), this model provides a two-dimensional framework for the development of electronic statistics and performance measures (see Figure 4). The model suggests that there are numerous components to electronic measures:

- *Technical infrastructure*: The hardware, software, equipment, communication lines, and technical aspects of the network (e.g., workstations, modems, servers).
- *Information content*: The information resources available on the network (e.g., local government information, special collections).
- *Information services*: The activities in which users can engage and the services that users may employ to complete various tasks (e.g., EbscoHost, UnCover, online applications).
- *Support*: The assistance and support services provided to help users to benefit from the network (e.g., training, help desk).
- *Management*: The human resources, governance, planning, and fiscal aspects of the network (e.g., network staff, advisory boards, budgeting).

In addition, there are different types of evaluation criteria that are used to describe library Internet-based use and services:

- *Extensiveness*. How much of a service the network provides (e.g., number of users accessing a Web page per week, number of database sessions);
- *Efficiency*. The use of resources in providing or accessing networked information services (e.g., cost per session in providing access to remote users of an online database, average number of times users are unable to successfully connect to the library's servers);

- *Effectiveness.* How well the networked information service met the objectives of the provider or the user (e.g., success rate of identifying and accessing the information needed by the user);
- *Service quality.* How well a service or activity is done (e.g., percentage of transactions in which users acquire the information they need);
- *Impact.* How a service made a difference in some other activity or situation (e.g., the degree to which network users enhanced their ability to gain employment or pursue business);
- *Usefulness.* The degree to which the services are useful or appropriate for individual users (e.g., percentage of services of interest to different types of user audiences); and
- *Adoption.* The extent to which institutions or users integrate and adopt electronic networked resources or services into organizational or individual activities (e.g., answering reference questions, generating interlibrary loan requests).

These types of criteria provide an important roadmap for thinking about the various data elements and statistics that would be necessary to produce such measures as well as providing a quality measurement framework for library networked services and resources.

	Network Evaluation Criteria						
	Extensiveness	Efficiency	Effectiveness	Service Quality	Impact	Usefulness	Adoption
Network Component							
Technical Infrastructure							
Information Content							
Information Services							
Support							
Management							

Figure 4. The Network Component Model.

The Network Component Model as a Quality Measurement Tool

As Figure 5 shows, the Network Component Model also serves as a mechanism through which to measure the quality of specific aspects of a library's networked services and resources using a number of evaluation criteria. It is possible to examine the technical infrastructure aspect of a network and consider network statistics and performance measures for that aspect along the evaluation criteria of extensiveness, efficiency, and so on. This framework enables one to map the network statistics and performance measures presented in Figures 2 and 3. For example:

- Technical Infrastructure and Extensiveness: Number of public access Internet workstations, maximum bandwidth of public access Internet workstations;

- Technical Infrastructure and Service Quality: Public access Internet workstations in proportion to the population of legal service area;
- Information Content and Efficiency: Percentage of remote library visits, number of users of electronic resources and services;
- Information Services and Extensiveness: Number of database sessions, percentage of serial titles offered in electronic form;
- Information Services and Efficiency: Percentage of electronic materials use of total library materials use; and
- Support and Extensiveness: User IT instruction, staff IT instruction.

Figure 5 also presents additional statistics and measures that selected library and state library staff and administrators, as well as various government officials and governing board members, found of interest. These include:

- Information Services and Service Quality: Number of rejected logins, percentage of rejected sessions to total sessions; and
- Management and Efficiency: Cost of online subscription material, cost per session/visit.

These statistics and measures, however, require additional development and testing.

The Quality Picture

Through these statistics and measures, it is possible to gain a sense of the quality of networked services and resources in specific areas or across a number of areas. Moreover, by selecting statistics and performance measures relevant and of interest to library staff and managers (required for reporting purposes) or other motivational factors, it is possible for libraries to develop an overall sense of their networked services and resources along the network dimension and evaluation criteria.

For example, should libraries desire to measure the quality of their database information services, they could use the following questions:

- How much? Such statistics and performance measures as the number of full-text titles available by subscription, number of database sessions, number of items examined using subscription services, and percentage of serial titles offered in electronic form.
- How well? Such statistics and performance measures as the number of rejected sessions, percentage of rejected sessions to total sessions, percentage of the time the network is functioning.
- Is it cost effective? Such statistics and performance measures as the cost of online subscription material, cost per session/virtual visit.
- With what effort? Such statistics and performance measures as the number of staff hours spent servicing public service information technology (IT), user IT instruction, and percentage of the population receiving IT instruction in the legal service area for public libraries.

Types of Measures	Network Components				
	Technical Infrastructure Technical aspects of the network (e.g., workstations, communications equipment)	**Information Content** Information resources available through the network	**Information Services** Activities and services that users may use (e.g., online databases)	**Support** Assistance and support provided to help users better use the network	**Management** Human resources, planning, governance, fiscal aspects of the network
Extensiveness How much of a service the network provides	• (W) Number of public access workstations • (W) Maximum bandwidth of public access Internet workstations	• (VV) Number of virtual visits to the networked library resources ☐ (VV) Total library visits	• (D) Number of full text titles available by subscription • (D) Number of database sessions • (D) Number of items examined using subscription services ☐ (D) Percentage of serial titles offered in electronic form	• (I) User IT instruction • (I) Staff IT instruction ☐ (I) Percentage of population of legal service area receiving IT instruction ☐ (I) Hours of formal IT instruction per staff member	

Figure 5. Network Library Quality Statistics and Performance Measures *(Continued on p. 770).*

Types of Measures	Network Components				
Efficiency					
The use of resources in providing or accessing network resources or services	• (W) Number of public access Internet workstation users ☐ Average annual use per public access Internet workstations • (ES) Level of paid public service effort in servicing IT ☐ (ES) Level of paid public service effort in servicing IT		☐ (D) Percentage of electronic materials use of total library material use ☐ (D) Total library materials use		• *Cost of online subscription material (e.g., e-books, databases)* ☐ *Cost per session/visit*
Service Quality					
How well a service or activity is done	☐ (W) Public access workstations in proportion to the population of legal service area		• *Number of rejected sessions* ☐ *Percentage of rejected sessions to total sessions* ☐ *Percentage of time network is functioning (e.g., up)*		

Adoption The extent to which institutions or users integrate and adopt electronic networked resources or services into organizational or individual activities			• (ES) Number of virtual reference transactions ▣ (ES) Total reference activity □ (ES) Percentage of virtual reference to total reference activity		

W=Workstations ES=Electronic Services D=Databases VV=Virtual Visits I=Instruction

• Network statistic (*italics indicates additional possible statistics*)

□ Performance measure (*italics indicates additional possible performance measures*)

Figure 5. Network Library Quality Statistics and Performance Measures.

Academic libraries could substitute campus populations such as student body, faculty, staff, and so on.

Such a systematic approach to network service quality measurement thus provides a library the ability to look in-depth at particular aspects of their networked services and resources.

Issues with Statistics, Performance Measures, and Framework

A review of the statistics, performance measures, and framework points to a number of issues that require additional research and testing:

- Network service and resource measurement across library types. Many of the statistics and performance measures presented in Figures 2 and 3 were developed in the public library and/or statewide library network environments. It is unclear as to whether these statistics and measures apply across an ever-complex library environment of cooperatives, consortia, regionals, multi-type digital libraries, or institutional libraries such as academic, research libraries, or others. There is a sense that some (i.e., online database statistics and performance measures) do translate across libraries or library service providers, but which ones, in what context, and so on, remains untested.
- Time-sensitive statistics and performance measures. Many of the statistics and performance measures presented in Figures 2 and 3 will have a limited utility time. Technology changes, measurement needs change, and libraries change. Thus, network statistics and performance measures will be in a continual state of development, testing, modification, and adoption.
- Control of the data. Some of the most central data to libraries is now out of the control of libraries—i.e., online vendor databases. Thus, the ability of libraries to collect, analyze, and use critical data is dependent on the ability of libraries to receive desired data back from the vendors in a timely, uniform, and consistent manner.
- Critical gaps. Figures 4 and 5 clearly demonstrate that there are a number of evaluation criteria and network components for which there are no tested statistics and performance measures to determine the quality of those networked services and resources. In particular, there is a need for quality indicators in key evaluation criteria of impact and usefulness. At present, quality measurement is limited to predominantly technology-generated logs, counts of equipment and/or equipment usage, and transaction data (e.g., reference). The more difficult questions of impacts, benefits, outcomes, and barriers remain unanswered.
- Mutual exclusivity of the statistics and performance measures. The quality framework presented in Figure 5, while parsimonious, has the obvious limitation of oversimplification. That is, a number of statistics and performance measures can serve as quality measures along more

than one evaluation criterion. For example, one might use the number of virtual reference transaction statistics as both a quality indicator of information services' *extensiveness* and *adoption.*

- Evolving methodologies. In part, the limitations to the types of network statistics and performance measures presented in the article are a result of the limitations of current data-collection techniques. More often, researchers rely on qualitative methods to gain a sense of user-based impact and utility measures. Relying on these methodologies to measure service quality across libraries, library types, and so on, is problematic at best. There is a need to modify existing data-collection techniques and/or develop new techniques (i.e., Web log file analysis) to better address measurement in the networked environment.
- Library data collection, analysis, and presentation management system. The research activities demonstrated that, in general, public libraries do not engage in a systematic quality-focused data-collection system. Few, if any, have staff that are responsible specifically for library-wide data-collection efforts, analysis efforts, or reporting and presentation efforts. Moreover, library staff may not be appropriately trained in the various methodologies and data analysis techniques required to engage in statistical and performance measurement activities. Were it not for state library and/or local governance mandated data-collection efforts, it is likely that many public libraries would engage in few, if any, data-collection efforts beyond circulation and visit counts. The data-collection situation is particularly problematic in the networked environment, as data-collection efforts in this area require additional technical and research skills.

These issues point to the need for additional research, testing, and validation in the area of network resources and services quality measurement. They also indicate a need for libraries to work with vendors to receive desired usage reports, as well as the enhancement of librarian technical, evaluation, and methodological skills to better understand the networked environment.

Next Steps

The framework presented in this article shows that it is possible to develop, define, and collect a number of statistics and performance measures that reflect networked library services and resources. The statistics and measures, however, reflect the embryonic state of network service and resource measurement due to a number of methodological, organizational, and complexity issues. As such, a large number of the statistics and measures reflect a "counting" approach to measurement.

While an important first step to network service and resource measurement is establishing a foundation for measurement, it is important

to move beyond counting instances and occurrences. The SERVQUAL methodology, which is reviewed substantially in other articles in this journal issue, provides a robust framework that network measurement activities need to consider in moving toward developing user-based measures of library network service quality. For example, a clear starting point is to consider statistics, performance measures, and approaches that incorporate the Gaps Model of Service Quality (Zeithaml, Parasuraman, & Berry, 1996):

- Gap 1—customers' expectations and management's perceptions of these expectations;
- Gap 2—management's perceptions of customer's expectations and service quality specifications;
- Gap 3—service quality specifications and actual service delivery;
- Gap 4—actual service delivery and what is communicated to customers about it; and
- Gap 5—customers' expected services and perceived service delivered (p. 16).

These gaps provide an overall research approach within which the network statistics and performance measure model presented in Figure 5 can serve to guide the development of specific network statistics and performance measures with the gap dimensions. As research in this area continues, adopting a user-based approach to library network service quality assessment is critical.

Conclusion

The network statistics, performance measures, and quality framework presented in this article consolidate the findings from a number of research activities conducted over several years. It is clear, however, that the development of service quality measures for libraries in the networked environment is still in the initial stages. It is also clear that, as library network usage measurement evolves, it is necessary to incorporate user-based quality assessment approaches such as those offered through the SERVQUAL methodology.

To stimulate research and practice in this area, though, it may be necessary to balance the more rigorous requirements of valid and reliable data with the very real needs of libraries and librarians of all types to demonstrate, in a standardized manner, the use and uses of their networked resources and services. This is not to say that researchers and practitioners should abandon sound social science research practices in their efforts to develop methodologies, variables, statistics, and performance measures that yield accurate, valid, and reliable network resource and service usage and quality data. Rather, in a rapidly evolving and constantly changing environment, such as the networked environment, researchers and

practitioners are likely to be in a continual cycle of developing new measures or modifying existing ones and developing new methodologies or modifying existing ones. This perpetual "under construction" scenario requires researchers and practitioners to experiment with new approaches to service quality measurement until such approaches are accepted by the broader research and library communities.

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