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Statistical Analysis Models: Applications
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Academic libraries face challenges in documenting their value to their presidents, provosts, and patrons while expanding services and maintaining tight controls on costs. This is nothing new for service oriented businesses facing competitive pressures in a market that places similar demands on their organizations. These businesses have developed techniques to calculate metrics such as ratios and other numbers that demonstrates a business's operational efficiency. Because of this, these same business methods developed for service industries in the private sector can be applied to library management. These techniques can identify which statistics a library should be collecting and how they should be used. This article will review the library literature within this business framework to identify which statistics are most useful measures of inputs, outputs and ratios for decision-making to improve operational efficiency, while also demonstrating value to the customer and to top level administrators.

Many studies have been conducted relating to the use of statistics in libraries but few have examined them in relation to analogous business practices. One of the first articles written about statistics was Richard Trueswell's article on the 80/20 rule, where he argued that eighty percent of patron needs will be satisfied by only twenty percent of the library collection.¹ This study looked at usage statistics in libraries, but did not examine the deeper question of what statistics would be worth collecting. Even after this landmark article, little has been written about what constitutes a core set of metrics for libraries. There has been some focus on inputs and outputs, but none of these correlate to standard business measurements.

Two articles come close to aligning their analysis of library inputs and outputs with standard business practices. Liu and Zweizig define these terms in their 2001 article.² They describe these as:

1. Input or resources measures used to describe characteristics of the resources that go into a library to support services.
2. Output measures describe the products of the library.
3. Processes measures, which are in between input and output measures, describe library activities that make the output possible.
4. Outcomes measures describe what the impact of library services or users or communities.

One of the greatest difficulties in identifying the comparative measures of inputs and outputs is to determine the efficiency of operations. Towards this end, Liu and Zweizig identify these factors as process measures.³ Process measures are simply efficiency ratios used by accounting and finance professionals to measure a company's efficient (or inefficient) use of resources. Building upon this model, standard inputs and outputs of a library can be examined as to how they might be analyzed and related to determine a library's efficiency and thus its value to customers. This can lead to benchmarking them against appropriate institutions.

Jones examines using input and output measures from Integrated Post Secondary Education Data System (IPEDS) for benchmarking in her 2007 paper in *College & Research Libraries*.⁴ This article presents the use of National Center for Education Statistics (NCES) data to compare and contrast measures of input and outputs of libraries of the top fifty liberal arts colleges from the 2004 *U.S. News & World Report*. The primary purpose of this paper was to demonstrate how the NCES data could be used to benchmark an individual institution against peer institutions for the purposes of assessment. The use of ratios, highlighted in the 2004 Association of College and

Research Libraries (ACRL) Standards for Libraries in Higher Education, does not place the focus on the application of business practices in statistical analysis.⁵

Benchmarking analysis is more than just a statistical exercise. In a recent article Lynch and her co-authors offer insights on which statistics college and university administrators consider important and their attitudes towards libraries and their centrality to the campus. The authors observed, “Presidents and provosts generally agreed that the library contributes fundamentally to the research and teaching missions of their institutions, with research taking priority.”⁶ This study is very important because it not only identifies how the people who ultimately control a library budget feel about their academic libraries, but it also identified some metrics in broad terms that provosts and presidents consider relevant. Lynch and her co-authors commented that presidents had a general consensus that there are three broad measures of a library’s centrality:

- Ability to acquire outside funding;
- Visibility and leadership on campus;
- Circulation and interlibrary loan statistics.

The research also indicated that innovative applications of technology, quality of personnel and collections, and quality of service to other campus units were also important indicators. Quality is thus considered important, but the presidents and provosts indicated they were less concerned with traditional statistics comparing the collection size or funding to similarly sized institutions.

Service Operations Management

Service businesses obviously do not report statistics to provosts or presidents, but they do have to report to shareholders or owners. They analyze inputs and outputs just as

libraries do, but using very sophisticated techniques identified in service operations management (SOM). SOM is both a field of study and a management approach in service industries. It has adapted techniques long used in manufacturing and marketing and applies them to service organizations.⁷ For instance, a typical manufacturer will measure its inputs such as raw materials purchased, and its outputs such as widgets manufactured and sold. These measures are typically compared in an inventory turnover ratio to measure the efficiency of operations, comparing an input and output by dividing cost of goods sold (output) by average inventory (input) to identify how quickly the organization sells its inventory. Similar measures can be developed by libraries to demonstrate a library's efficient use of resources.

SOM includes seven elements that define the nature of a service organization and can indicate what measures of input and output might be used in analyzing a service organization (and more specifically a library). The elements include:

- the customer is a participant in the service process;
- there is simultaneous production and consumption of service, with delivery in real time;
- the service deliverable is intangible (but may include supporting goods);
- services have no inventory because capacity is time perishable;
- service output (quality and productivity) is difficult to measure;
- the service location is dictated by proximity to customers; and
- services tend to be labor intensive.⁸

Although, service output is difficult to measure, as noted above, libraries still track production cycle inputs through measures like personnel budgets, book budgets, number of items purchased, and electronic resources budget. Outputs can be measured using many of the standard statistics collected over time such as checkouts and reference requests.

ACRL has defined inputs as the raw materials of a library program—the money, space, collection, equipment, and staff, out of which a program can arise.⁹ These library inputs can be arranged in two broad categories:

- Budgets
 - resource budget (both paper and electronic);
 - personnel budget;
 - operating costs (separate from resource and personnel);
 - capital costs (separate from resource and personnel);
- Counts
 - number of items/resources purchased;
 - number of items/resources in the collection.

Individual libraries may break these down in more specific ways by organizational structures or functions, but all libraries have capital and operations budgets and purchase a quantity of information resources. By themselves these input measures have traditionally served as indicators of library performance.¹⁰ However, these statistics are less useful because they reflect little about how a library meets the customer's needs or the operating efficiency of the organization. As the study by Lynch et al. points out, presidents and provosts were not concerned with how a given library's budget compares to a peer or aspirant institution. Collection size might indicate what is available for students to use but does not indicate how well it supports the curriculum or reading demands of the students.

Libraries have a variety of output measures which are largely dependent on the types of services they provide, as well as the ability of the library organization to gather these statistics. Davies defines outcomes or outputs as comprising the contributions that the information and library service makes to the activities of clients or end-users. He also

adds that impacts would measure how library services sustain learning and research.¹¹

ACRL simply defined outputs as the quantity of work done, and these can be broken down into two basic categories:¹²

- Resource Usage
 - Electronic resource usage (COUNTER and related statistics);
 - Print usage (checkouts, renewals, in-house use counts, etc.);

- Services
 - Exhibits;
 - Gate counts;
 - Library instruction (sessions, number of students, hours);
 - Public events (attendance and number of events);
 - Reference requests/research appointments.

Individual libraries may arrive at additional types of services or resources to be quantified, but ultimately these measures provide the means of access to an information resource or adding value to that resource through services such as library instruction, reference services, and the organization of the sources. These statistics are more indicative of the value to the customer, for example, presidents and provosts interviewed by Lynch, et al agree that circulation and inter-library loan statistics are an important measure of the library's centrality.¹³ Other statistics that are not specifically mentioned, but can measure the library's value to customers might include the number of students receiving library instruction, usage of electronic resources, counts and types of reference questions, etc. In any case, further study of what library performance measures are desired by top level administrators is warranted.

Marketing can help to persuade administrators as to what are reliable and valuable metrics. Knowing your customers is an essential marketing activity, but little research has been published on what statistics are most valuable for use in marketing academic

libraries. Koontz writes extensively about customer data in marketing, and argues that given the competitive environment in which libraries operate today, they can no longer be passive in marketing library services. She indicates that competitive organizations strive to know who their customers are, what product choices they may make, and where they live.¹⁴ For academic libraries, much customer data will reside with the registrar, admissions, and institutional research professionals who have a significant amount of demographic information about student populations. This alone does not provide information on what services these students want and use in the library, so libraries have typically gathered this data through use analysis (ex., Circulation counts, in-house use counts, gate counts, etc.) and survey data including service gap surveys (ex., LibQual).

Operational and Efficiency Analysis

Statistical analysis is a major part of finance and operations management in modern businesses. A company uses and analyzes ratios to achieve efficient use of resources. These ratios may focus on specific functions such as inventory management, cash flows, and their debt risks. Libraries can not necessarily use the same ratios. However, a comparative analysis of the inputs and outputs with a standard set of ratios that would be acceptable to library “industry” would be very useful for analyzing and benchmarking a library’s operations. To understand this better, these metrics can be examined through three basic business functions:

- **Finance:** The way in which organizations acquire and manage funds for the continuing operations.¹⁵
- **Marketing:** The craft of linking producers of a product, service, or idea with existing and potential consumers.¹⁶
- **Operations:** The area concerned with the efficiency and effectiveness of the operation in support and development of the firm’s strategic goals.¹⁷

Each of these areas requires a different kind of statistic to be used in different ways. As Sumsion noted, statistics can be used for: monitoring operational effectiveness, providing a basis for strategic planning, demonstrating value (or potential value), and understanding users.¹⁸ Others have identified specific efficiency measures such as Henderson who wrote of the “library collection failure quotient.” This number is a ratio of inter-library loan borrowing to collection size, which is used to measure how well a collection meets the needs of the patrons.¹⁹

By and large, ratio metrics have not gained popular recognition as a broad usage within libraries. The advantage of these is that they can compare inputs / outputs to give some sense of the impact on services. Examples of measures that might include ratios are:

- Circulation/library operating budget;
- In-house use counts/library operating budget;
- Gate counts/library budget;
- Library instruction sessions/costs and/or numbers of students;
- Reference counts/library operating budget;
- Number of searches/Cost of electronic resources.

For example, examining the 2004 IPEDS statistics and running an analysis of circulation statistics (CRGEN) against total expenditures (EXTOT), the mean ratio of circulations to expenditures for all contributing libraries is 0.0323 (a range of 1.0877 to smallest at 0.0000048).²⁰ This provides a rough estimate that on average it costs three cents to circulate an item among these reporting libraries. Ideally, the ratio would include circulation counts against the expenditures for operating the circulation department, depreciated value of the items circulated, and costs of storage. In practicality, it is

difficult to be that precise without the accounting infrastructure to calculate or evaluate an organization at this level of precision. Still, if there is consistent practice in calculating such ratios, they can be useful in benchmarking the efficiency of operations of a library as well as calculating customer value.

Typically, libraries report standard inputs and outputs to the Association of Research Libraries (ARL) and the IPEDS but not measures of efficiency. To address this, the ACRL Board of Directors made specific recommendations in the 2004 standards report where they offer a number of suggested ratios for points of comparison.²¹ Some of the ratios suggested can be calculated from IPEDS or ARL data. Jones suggests the use of the IPEDS for this purpose and demonstrates how they might be used for benchmarking.²² More research could be done on determining which statistics libraries use and if they calculate ratios from this data for efficiency or other purposes. To make use of these data, more current comparison data is required; IPEDS data are not reported in a timely manner (at the time this article is written the data posted is currently four years old). Ultimately, these numbers have to be more current and complete if they are to allow managers to make better decisions.

The statistics and ratios should demonstrate value to the customer proving the need for libraries, whereas the efficiency of operations demonstrates the good use of resources and support for continued or expanded funding. This means that library managers need to think critically about which statistics are useful, because while they can prove the value of the library with administrators, they also can be expensive and time consuming to gather.²³ If the identified statistics do not affect decision making, better funding, and more efficient use of given resources; there is little value in collecting them.

In a 1985 article Allen asked, “How often is there any valid analysis of the resulting figures, or the proposal of policy changes based upon changes in need demonstrated by the numerical data?”²⁴ In finance, businesses have used ratio statistics extensively to identify sound investment while marketers use demographic numbers to identify market and service niches. In operations, statistics now play a major role in most businesses due to the advent of total quality management and Six Sigma certification. Libraries should look toward these statistical analysis models to ensure the best use of diminishing resources and maintain value added high quality service in the competitive environment of information resource providers. Frank, Madden, and Simons commented on these problems, stating that statistical analysis can be used to identify patterns and trends as well as influence decision makers by supporting academic librarians’ positions when confronted with competing academic departments.²⁵ To document the library’s value to customers requires thoughtful analysis and the use of techniques that show efficient use of resources and services that patrons’ value.

Statistics are an important component in evaluating an organization to improve managerial decision making, demonstrating value, and garnering resources. Librarians may be good at counting but as a whole, the profession is not trained to evaluate and analyze statistics. Librarians offer numbers often as proof of the value of their work with little thought as to whether those numbers really establish anything of value.²⁶ Peter Hernon asked in his 1989 article, “How much research and statistical competence should library managers and decision makers have?” He argues that the analysis and interpretation of statistics should be completed by librarians who have a background in the research process and the use of statistics.²⁷

This is not to say libraries' should adopt business practices in library management. Libraries are not profit centers but rather service centers and therefore the goal of all libraries is to maintain and improve services in meeting the needs of their patrons. As stated at the beginning, there are many practices associated with SOM that can be used to analyze the effectiveness of a service and whether it is more costly than the value it provides. The approaches of business analyses can also be used by libraries to improve efficiencies and lower costs while providing better service.

Recommendations

ARL and other organizations have done much to standardize the kinds of statistics libraries track and report. More can be done to work toward a standard approach to the use of statistics to meet the business needs of the organization. To do this, the library profession needs to conduct more research on which statistics are important for managing operations, marketing and development within the library. This research can move forward efforts to identify "industry" accepted standards, and better educate librarians and library students on the use of statistics in managing libraries. Lynch and her co-authors reported some important findings on what measures college and university administrators find important, but further research needs to be done in this area. Doing this will also help to identify which measures demonstrate a library's value. Other research similar to Henderson's on the library collection failure quotient can provide greater understanding of what ratios show an efficient use of resources and value to customers. Little has been published in the library literature on the usage of ratios in managing libraries and to demonstrate the efficiency of operations and customer value.

Some of the research has called for more standardization in statistics. ACRL Statistics Committee and the ACRL Board of Directors has been working to address the issue of statistics in libraries; however, the profession has farther to go. More research is needed on which measures is being used, as well as the training required to interpret them. Just as industries have identified some of their key ratios with operations managers and financial analysts, so should libraries be able to come to an agreement based on research and practice. In the end, library managers should be as well versed in the use of statistics as any operations manager or marketing professional in a business.

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