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ABSTRACT

The SERVQUAL measure was developed by A. Parasuraman, L. Berry, and V. Zeithaml (1988) to measure perceptions of service quality, originally in the retailing sector. However, libraries and other educational institutions are also service providers. Librarians in particular have increasingly become interested in measuring quality of service as the ultimate assessment of library performance, as against more traditional measures of performance such as counts of various holdings. This study explored SERVQUAL score validity in the library service context using data from 596 users representing 3 user groups with measurement at 3 times over 6 years. Second-order factor analysis provided mixed results with regard to the psychometric integrity of SERVQUAL scores applied within the library service context. (Contains 3 tables and 34 references.) (Author/SLD)

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Higher-Order Factor Analysis as a Score Validity Evaluation Tool: An Example with a Measure of Perceptions of Library Service Quality

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Paper presented at the annual meeting of the Southwest Educational Research Association, Dallas, January 27, 2000.

Abstract

The SERVQUAL measure was developed by Parasuraman, Berry and Zeithaml (1988) to measure perceptions of service quality, originally in the retailing sector. However, libraries and other educational institutions are also service providers. Librarians in particular have recently become increasingly interested in measuring quality of service as the ultimate assessment of library performance, as against more traditional measures of performance such as mere counts of various holdings. The present study explored SERVQUAL score validity in the library service context using data from 596 users representing three user groups and measurement at three times over six years. Second-order factor analysis provided mixed results as regards the psychometric integrity of SERVQUAL scores applied within the library service context.

The call for accountability in higher education is as strident as ever. Rather than relying exclusively on traditional expenditure-driven metrics, university library administrators are now seeking novel methods to assess effectiveness in fulfilling university goals. A case in point is the New Measures initiative in the Association of Research Libraries (ARL), which is exploring alternatives to historical assessment practices. Recently libraries have focused more directly on their role as service providers and have explored mechanisms to gauge their performance *as service agents*.

Indeed, several studies have been conducted in library settings using the SERVQUAL protocol developed by Parasuraman, Berry and Zeithaml (cf. 1988, 1991; Andaleeb & Simmonds, 1998; Coleman, Xiao, Bair & Chollett, 1997; Cook & Thompson, 2000; Edwards & Browne, 1995; Hebert, 1994; Nitecki, 1996a; Stein, 1997; White, 1994), though the SERVQUAL measure was originally developed for use the retailing sector. SERVQUAL has now been used for over 10 years in a host of profit and non-profit institutions to assess service quality. SERVQUAL's applicability to libraries continues to be explored; under the New Measures initiative in 2000 ARL is sponsoring a pilot administration of the instrument to several hundred representatives of various user groups at 12 of its ARL-member institutions.

In applying any measurement protocol across settings, it is critical to remember that tests are not *per se* reliable or valid (Thompson, 1994). As emphasized in various recent professional

standards (cf. Joint Committee on Standards for Educational Evaluation, 1994; Wilkinson, L., & The APA Task Force on Statistical Inference, 1999), these properties inure instead to scores. A given measure may yield psychometrically sound scores in some contexts or with some samples, and not in others. Thus, it cannot be assumed that a measure such as SERVQUAL, which may work well in business settings, will necessarily work well in library service settings (Vacha-Haase, 1998).

Given the library profession's continued investment in SERVQUAL as one service quality psychometric assessment, an essential question focuses on the construct validity of SERVQUAL scores, i.e., does it measure what it intends to measure, or more fundamentally, what does SERVQUAL measure? Only with knowledge of what SERVQUAL actually measures in the research library setting, can library administrators and ARL be assured of SERVQUAL's applicability as a tool for assessing quality service in a research library context.

Role of Higher Order Factor Analysis

Factor analysis and construct validity have long been associated terms. Nunnally (1978) commented that "construct validity has been spoken of as 'factorial validity'" (p. 111). Furthermore, he asserted, "Factor analysis is intimately involved with questions of validity... Factor analysis is at the heart of the measurement of psychological constructs" (pp. 112-113).

Factor analysis organizes a group of related variables by the smallest reasonable number of latent, or hidden, dimensions. The

philosophical foundation of factor analysis invokes Occam's Razor, or the Law of Parsimony, i.e., shaving an argument to its simplest possible terms. William of Occam, a 14th century cleric and philosopher, stressed the Aristotelian principle that elegant solutions are optimal, or in modern day parlance, KISS (keep it simple, stupid).

As Tinsley and Tinsley (1987) wrote, "The goal of factor analysis is to achieve parsimony by using the smallest number of explanatory concepts to explain the maximum amount of variance in a correlation matrix" (p. 414). Thurstone (1947), an acknowledged seminal figure as regards factor analysis, suggested that, "A factor problem starts with the hope or conviction that a certain domain [i.e., the range of phenomena that is represented in any factor analysis] is not so chaotic as it looks..." (p. 55). He added, "The analysis might reveal an underlying order which would be of great assistance in formulating the scientific concepts covering the particular domain" (pp. 55-56).

It is noteworthy as well that factor analysis is an appealing analytical tool for evaluating validity, because the analysis concentrates on the most reliable aspects of test data (Gorsuch, 1983). Thompson (1982) noted, "Since the 'common variance' represented by indices of association tends to represent reliable variance, and since it is from these indices that factors are extracted, it follows that factors tend to be constructed from the 'true score' components of variables" (p. 4).

Although many researchers are familiar with factor analysis

and methods used in generating and interpreting first-order factors, the concept of second- and subsequent higher-order factors is less well understood. As Kerlinger (1984) noted, "while ordinarily factor analysis is probably well understood, second-order factor analysis, a vitally important part of the analysis, seems not to be widely known and understood" (p. xiv). The fact that higher-order factor applications are not included in the standard statistical packages, such as SPSS and SAS, contributes to the infrequency with which this important analytical tool is applied.

Second-order factor analysis is appealing conceptually, because there are many phenomena intuitively considered to be ordered within hierarchies. For example, the developers of SERVQUAL theorized that quality service consisted of a higher order construct of quality service defined by five primary-order factors.

McClain (1996) suggested that the factor levels taken together can provide *different perspectives* on theoretical constructs. Thompson (1990) explained, "The first-order analysis is a close-up view that focuses on the details of the valleys and the peaks in the mountains. The second-order analysis is like looking at the mountains at a greater distance, and yields a potentially different perspective on the mountains as constituents of a range" (p. 579).

And Gorsuch emphasized that,

> Rotating obliquely in factor analysis implies that the factors do overlap and that there are, therefore, broader areas of generalizability than

> just a primary factor. Implicit in all oblique rotations are higher-order factors. It is recommended that these be extracted and examined so that the investigator may gain the fullest possible understanding of the data. (p. 255)

In other words, whenever we obtain correlated first-order factors, we should then in turn factor the correlations (or covariances) of the first-order factors to then identify the underlying latent second-order factors.

Higher-order factors are central to the issue of generalizability. As Gorsuch (1983) noted, "Primary factors indicate areas of generalizability. More generalization can occur within a factor than across factors, but this does not eliminate generalization across factors. When factors are correlated, some generalization is possible. These areas of generalization across the primary factors form the higher-order factors" (p. 240).

Purpose Of the Present Study

The SERVQUAL protocol developed by Berry, Parasuraman and Zeithaml (cf. Parasuraman, Berry & Zeithaml, 1988, 1991; Parasuraman, Zeithaml & Berry, 1985, 1994; Zeithaml, Berry & Parasuraman, 1996) is a 22-question instrument designed to assess customer perception of service quality. After extensive qualitative and quantitative study, Berry et al. theorized that quality service is a higher-order abstraction consisting of five primary-order dimensions: *tangibles*, *reliability*, *responsiveness*, *assurance* and *empathy*. In conformity with their theory, they constructed SERVQUAL

to assess total quality service through these five dimensions.

The present study addressed the research question, "Do perceptions of quality service emerge as the expected five first-order and single second-order construct for the SERVQUAL protocol in the research library setting, thus corroborating score validity of the instrument?". Although SERVQUAL has been the subject of over 20 dissertations (Nitecki, 1996b, p. 183) and several factor analyses, only Kelley and Hoffman (1997) report results from a hierarchical factor analysis perspective. Factor analysis was not the focus of their study, but they did embed a second-order structure within a more general model they evaluated using structural equation modeling (cf. Thompson, in press).

Methods

Sample

Our sample involved the perceptions of 596 undergraduate, graduate student, and faculty respondents to the SERVQUAL questionnaire from the three biennial administrations of the instrument at the General Libraries, Texas A&M University. Table 1 presents a description of sample sizes across the three user groups and the three times of SERVQUAL administration.

INSERT TABLE 1 ABOUT HERE.

Instrumentation

The SERVQUAL protocol (cf. Parasuraman, Berry & Zeithaml, 1988, 1991; Parasuraman, Zeithaml & Berry, 1985, 1994; Zeithaml, Berry & Parasuraman, 1996) consists of 22 items, and user

perceptions of (a) minimally-acceptable, (b) perceived, and (c) desired service expectations can all be measured. However, there is considerable debate within the service quality literature as to whether service quality should be measured as the difference between a respondent's perceptions and expectations, or whether perceptions only should be considered. Although scores for desired and minimum expectations were also collected, here only perceptions scores were analyzed in conformity with Zeithaml, Berry and Parasuraman's (1996) recommendation,

> Although this issue continues to be debated, there is some agreement that a study's purpose may influence the choice of which measure to use: The perceptions-only operationalization is appropriate if the primary purpose of measuring service quality is to attempt to explain the variance in some dependent construct; the perceptions-minus-expectations difference-score measure is appropriate if the primary purpose is to diagnose accurately service shortfalls. (p. 40)

Results

Computer program SECONDOR (Thompson, 1990) was used to conduct the analysis using principal components methods. Given that the first five eigenvalues of the correlation matrix, associated with the factors prior to rotation (Thompson, 1989), were 11.85, 1.20, 1.04, .76, and .74, both the "scree" test and the Guttman/Kaiser eigenvalue-greater-than-one rule (Guttman, 1954) thus suggested

that three first-order factors should be extracted.

These were then rotated to the promax criterion using a pivot power of 3 (Gorsuch, 1983). Table 2 presents the promax-rotated factor pattern and structure coefficients (cf. Thompson & Daniel, 1996) for the first-order solution. Because the factors are correlated through an oblique factor rotation such as promax, and thus pattern and structure coefficients are not equal, it is advisable to interpret both to obtain an accurate analysis, in the same manner that both weights and structure coefficients should be interpreted when evaluating regression results when predictor variables are correlated (Thompson & Borrello, 1985).

INSERT TABLE 2 ABOUT HERE.

The three-first order factors were highly correlated, as expected: $r_{I \times II}^2 = .557^2 = 31.0\%$; $r_{I \times III}^2 = .659^2 = 43.4\%$; $r_{II \times III}^2 = .620^2 = 38.4\%$. As noted previously, such results imply the presence of one or more higher-order factor.

The first two eigenvalues of this matrix were 2.22 and .45, thus one second-order factor was extracted from the first-order factor correlation matrix. The three second-order factor pattern/structure coefficients (Thompson & Daniel, 1996) were .858, .839, and .886, respectively.

Interpreting higher-order factors, however, can be a dicey proposition. Many researchers err in interpreting second-order factors only in the light of first-order factors (Thompson, 1985, p. 430). As Gorsuch (1983) noted,

> Interpretations of the second-order factors would need to be based upon the interpretations of the first-order factors that are, in turn, based upon the interpretations of the variables... To avoid basing interpretations upon interpretations upon interpretations, the relationships of the original variables to each level of the higher-order factors are determined. (p. 245)

Gorsuch (1983, p. 247) suggested, therefore, that the first-order factor pattern matrix be postmultiplied by the second-order factor pattern matrix. This can be done as part of the use of a related analytical strategy developed by Schmid and Leiman (1957) to assist in the interpretation of second-order analyses. Table 3 presents a Schmid-Leiman solution for these results.

INSERT TABLE 3 ABOUT HERE.

The first column of coefficients in Table 3 contains the weights from the product matrix that allows direct interpretation of the second-order factors in terms of the original 22 items (rather than the three first-order factors). The next three columns contain the residualized variance in each of the first-order factors, respectively, after the variance attributed to the second order was removed. Thus the second-order results and the residualized first-order factors presented in Table 3 present non-overlapping variance unique to each perspective.

Discussion

The hierarchical factor analysis of the data from the 596 responses to the SERVQUAL questionnaire partially supports the theoretical construct of service quality in the research library setting. Our results are noteworthy in part because our sample size was large relative to the number of items and relative to the sample sizes used in previous first-order factor analytic studies of SERVQUAL.

Promax-rotated First-order Factors

As in earlier factor analyses of SERVQUAL data in libraries (Nitecki, 1996a; Cook & Thompson, 2000), the first-order analysis of the data did not retrieve the five dimensions conceptualized by its originators: reliability, responsiveness, assurance, empathy and tangibles. Instead, three dimensions emerged from the data, as reported in Table 2.

The first dimension, *tangibles*, did include the four questions intended by the SERVQUAL designers, but also included one question, "convenient business hours" intended to fall in the *empathy* dimension. The second factor, *reliability*, or "*service efficiency*," also included the five questions intended to measure the reliability factor, but also included two others questions: (a) "keeping customers informed about when services will be performed," intended to fall under the *responsiveness* dimension, and (b) "assuring customers of the accuracy and confidentiality of their transactions," intended to fall under the *assurance* dimension.

The remaining 10 questions, designed to define discrete dimensions of *assurance*, *responsiveness* and *empathy*, collapsed into

a single dimension that appears to measure "*affect of service*." These results are in keeping with other reported factor analyses of the SERVQUAL protocol in libraries.

Second-order Factor

On the other hand, the higher-order analysis of the perceptions did capture a single, higher-order factor, "*service quality*," as theorized. Table 3 presents the Schmid-Leiman solution from the analysis. As reported in Table 3, with coefficients all ranging from .539 to .804, the 22 questions can be construed to represent a generic higher-order dimension of quality service in libraries. The second-order factor is an overarching view of user perceptions of service quality at the Texas A&M University Libraries.

Residualized First-order Factors

The next three columns (residualized first-order factors I, II, and III) of Table 3 contain the residualized variance in each of the first-order factors after the variance attributed to the second order was removed. It is interesting to note that the residualized first-order Factor I still retained 5.23% of the total variance [1.15 / 22 x 100]. The following questions contributed most to the remaining variance in Factor I after that variance present in the second-order factor was removed: (a) .499, "employees who are consistently courteous;" (b) .450, "employees who deal with customers in a caring fashion;" and (c) .349, "willingness to help customers."

These questions are related in that they connote warmth on the

part of the service agent, a feeling in which a user might perceive that library staff cared about that user's needs on a personal basis. General service quality and specific warmth seem to be discrete dimensions. Our results suggest that a user might have good feelings about service delivered with warmth, perhaps even if a correct answer to a question is not delivered. Warmth is a nuance factor, identifiable in itself, and separate from the big picture of quality library service.

Summary

The higher-order factor analysis of the perceived scores from the three administrations of the SERVQUAL protocol at Texas A&M University suggests a hierarchical structure underlies perceptions of quality service in research libraries. Although a first-order factor analysis resulted in three, rather than five, first-order dimensions for the protocol, a second-order analysis did recover a single higher-order abstraction of general service quality, as posited by the originators of the instrument.

It is important to remember that first- and second-order analyses provide different perspectives of a phenomenon, and that both can be useful interpretive guides. The first-order factors, the individual mountains in a range, allow one to look at the singular characteristics of the mountain: the peaks, the valleys, the flora and fauna. The second-order factor allows one to view the entire mountain range and to absorb the full panorama, to see a full system in effect, although in the process the individual characteristics lose clarity.

To some extent, the present study validated SERVQUAL as an assessment tool for evaluating service quality in libraries. The instrument seems to measure three primary-order dimensions that generalize into a higher-order factor of quality service. However, it is possible that service quality in libraries is defined by dimensions in addition to the three identified in factor analyses of the SERVQUAL protocol in the research library setting to date, because the measure is generic and there are likely to be salient factors relevant to particular service settings. Future qualitative research needs to be undertaken (and is on-going) to further identify and test theoretical dimensions of quality library service.

With the caveat that the tool does not seem to capture the entire complement of underlying factors of quality service in libraries, SERVQUAL nonetheless seems to hold promise as an assessment tool. The notion of using the tool to generalize across libraries in similar settings is also supported to some degree in that a single higher-order factor was identified in the study, although simplistic rankings of libraries by SERVQUAL scores cannot be recommended. The protocol may be useful, however, in identifying libraries with best service practices that other libraries may then emulate, a highly recommended strategy for a profession focusing on the user of library services.

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Table 1
Participants Broken Down by
Role Group and Year

Role Group	Year 1995	1997	1999	Row Total
undergraduate	67	65	37	169 (28.4)
graduate	57	92	108	257 (43.1)
faculty	32	78	60	170 (28.5)
Column Total	156 (26.2)	235 (39.4)	205 (34.4)	596 (100.0)

Note. Percentages are presented within parentheses.

Table 2
First-order Promax-rotated Pattern and Structure Coefficients

Item No.	Pattern			Structure		
	I	II	III	I	II	III
1	.215	.631	-.008	.562	.746	.526
2	.028	.891	-.162	.417	.805	.409
3	.193	.671	-.053	.531	.745	.490
4	-.014	.727	.089	.450	.775	.531
5	.175	-.141	.759	.597	.428	.787
6	.033	.090	.650	.511	.512	.727
7	-.079	-.021	.947	.534	.523	.882
8	.304	.013	.586	.697	.545	.794
9	.162	-.014	.716	.627	.521	.815
10	.532	-.008	.327	.743	.492	.673
11	.679	.013	.232	.839	.535	.687
12	.045	.055	.726	.554	.531	.790
13	.534	.116	.270	.776	.581	.694
14	.972	.019	-.175	.867	.452	.477
15	.465	.112	.307	.730	.561	.683
16	.460	.012	.389	.724	.510	.700
17	.052	.316	.426	.509	.609	.657
18	.875	.054	-.061	.866	.504	.550
19	.528	-.034	.397	.771	.507	.724
20	.561	.165	.208	.790	.607	.680
21	.510	.216	.191	.757	.619	.662
22	-.308	.469	.463	.258	.584	.550

Table 3
Schmid and Leiman Solution

Item	Intended Factor	Second-Order	First-order I	First-order II	First-order III	h^2
6	tangibles	.707	.111	.344	-.004	.63
17	tangibles	.627	.014	.485	-.075	.63
19	tangibles	.681	.099	.365	-.025	.61
21	tangibles	.677	-.007	.396	.041	.62
4	reliability	.705	.090	-.077	.352	.63
9	reliability	.680	.017	.049	.301	.56
11	reliability	.754	-.041	-.011	.438	.76
14	reliability	.791	.156	.007	.271	.72
16	reliability	.762	.083	-.007	.332	.70
1	responsiveness	.740	.273	-.004	.151	.64
8	responsiveness	.799	.349	.007	.107	.77
10	responsiveness	.728	.023	.030	.336	.64
15	responsiveness	.795	.274	.063	.125	.73
2	assurance	.694	.499	.010	-.081	.74
12	assurance	.765	.239	.061	.142	.67
13	assurance	.750	.236	.007	.180	.65
22	assurance	.688	.027	.172	.197	.54
3	empathy	.743	.450	.029	-.028	.76
5	empathy	.777	.271	-.018	.184	.71
7	empathy	.804	.288	.090	.096	.75
18	empathy	.789	.262	.118	.089	.71
20	empathy	.539	-.158	.255	.214	.43
Trace		11.71	1.15	.78	.96	14.60

Note. The column after the orthogonalized matrix presents the sum of the squared entries in a given row. The first column represents the product of the three first-order factors times the second-order factor. The next 3 columns represent the first-order solution, based on variance orthogonal to the second order (Gorsuch, 1983, pp. 248-254).

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