Pragmatic Perspectives on the Measurement of Information Systems Service Quality

Analysis with LISREL: An Appendix to "Pragmatic Perspectives on the Measurement of Information Systems Service Quality"

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This Appendix aims at serving two purposes. First it will discuss the cross-validation of the 13 item SERVQUAL short-form as presented by Lee and Kettinger (1996) and, secondly, it serves to introduce multiple group analysis to the MIS field.

Cross Validation: Comparing the Similarity of the Factor Structures of Multiple Samples

IS-adapted SERVQUAL research has not statistically compared factor structures across different organizational samples. A rigorous statistical test should be undertaken to avoid possible biased judgments in cross-validating the levels of fit. As recommended by Chin & Todd (1995), a method to cross-validate an instrument's dimensionality is to compare factor structures in multiple samples. To achieve this, multiple group analysis with LISREL (MGAL), a statistical technique frequently used in marketing, can be employed to cross-validate a refined model with another independent sample. This analysis allows simultaneous factor comparisons between two or more samples by testing the invariance between them.

Based on the identified need for cross-validation (Segars & Grover, 1993; Chin & Todd, 1995), our refined measurement model [SERVQUAL Sample 1] was cross-validated with a separate sample from a different organization. The SERVQUAL instrument was distributed to 80 IS users of information services of another large business school [hereafter referred to as SERVQUAL Study Sample 2], resulting in 48 usable responses. In applying the refined SERVQUAL Study Sample 1 factor structure to the SERVQUAL Sample 2, the two sample groups were stacked together for simultaneous estimation. This analysis is based on the assumption that if the factor pattern matrices are identical across groups, then equal measurement exists across groups for each observed variable
(Smith, Tisak & Green, 1991).

A systematic way of testing the factorial invariance of the measures involves the testing of a series of hierarchical hypotheses (J”reskog & S”rbam, 1989; Hoelter, 1983, Bollen, 1989; and Smith, 1991). Factorial invariance, as Hoelter (1983) points out, involves two sets of issues. The first issue concerns the invariance of factor patterns and the second concerns the invariance of measurement error. Using the results of these hypotheses below, we can differentiate sources of factorial invariance. To conduct this analysis, a preliminary test of invariance across groups in terms of their covariance structures (i.e., $\sum^1=\sum^2$) is completed (refer to Ho1. in Table 1).

If this test fails to reject the hypothesis, all the factor loadings, pattern and even error variance are assumed to be invariant at some significance level. If the hypothesis is rejected, a series of additional hypotheses need to be tested to determine what is responsible for the unequal covariance structures. As suggested by J”reskog and S”rbam (1989) and Hoelter (1983), the following additional hierarchical hypothesis testing should be undertaken:

Ho.2: $\wedge^1= \wedge^2$ (invariance of factor patterns).

Ho.3: $\wedge y^1 = \wedge y^2$ (invariance of factor patterns and factor variance).

Ho.4: $\Theta_1 = \Theta_2$ (invariance of factor patterns and measurement error variance).

Ho.2 does not imply any equality on parameters and is concerned only with the number of factors and pattern of items loading on factors. Rejecting this hypothesis may indicate that the meaning associated with the items, and therefore the underlying factors, is different for the samples involved. If Ho.2 is not rejected (i.e., when groups have invariant factor patterns), two additional hypotheses, Ho.3 and Ho.4 should be tested to determine whether the unequal covariance structures for the groups involved are a result of differences in error variation, either as random or systematic errors of measurement.

Below is the general model description for two independent samples (See Formula 1). The two models are stacked together in a single LISREL run so that the desired constraints (e.g., $\Lambda^1 = \Lambda^2$) can be entered between groups and then the models can be estimated simultaneously. To estimate the two measurement models simultaneously, LISREL minimizes the fit function, which is the weighted average of the fits achieved for each group separately.

(Formula 1)

$$F = \sum_{g=1}^{G} (N_g / N) F_g$$

$$where: F_g = \log \|\Sigma\| + tr(S\Sigma^{-1}) - \log \|S\| - (p + q)$$

Ng is the sample size in group g; N = N1 + N2 + N3+...+ Ng

While all the free parameters are given new values, LISREL will enter exactly the same new estimates for the constrained coefficients that are assumed to be equal in the two groups. LISREL then recalculates the ∑ for each group respectively, compares the ∑ and S for each group and a revised estimate of the overall fit using the fit function above. After locating the set of estimates providing the best fit between the ∑'s and S's, the proximity of the match between the stacked model-implied ∑'s and the observed S's can be judged using the likelihood ratio *x2* multiplying by the value of F-function (Formula 1) by the overall number of cases. As a better goodness of fit index for MGAL, a restricted chi-square test has been developed using comparative *x2* (Smith et al, 1991; Werts, Rock, Linn & J”reskog, 1977). Based past marketing research, this restricted chi-square test, which assesses the significance of the differences in chi-square values across the two samples can be used. This can be accomplished by subtracting the degrees of freedom and chi-square value obtained from running both samples simultaneously within a single analysis, from the sum of the degrees of freedom and chi-square values of both samples run individually. If the chi-square difference is significant, then the fit of the hypothesized model to the data differs between samples.

Using this method, the results of the tests between the SERVQUAL Study Sample 1 and the SERVQUAL Study Sample 2 are given in Table 1.

Table 1. Findings from Multiple Group Analysis Between SERVQUAL Study Sample 1 and 2

Hypothesis	Restrictive chi-square	Difference in d.f.	Decision
Ho1. $\sum^1=\sum^2$	120.9	21	reject
Ho2. $\Lambda^1 = \Lambda^2$	* x^2/d.f=2.4	0	fail to reject
Ho3. $\Lambda y^1 = \Lambda y^2$	22.07	13	fail to reject
Ho4. $\Theta_1 = \Theta_2$	117.46	26	reject

*This hypothesis does not actually impose any equality constraint on parameters, it only states that the number of factors for both samples is the same. Thus, the overall x^2 values obtained from multiple group analysis is the sum of two x^2 values that would be obtained if the two samples were analyzed separately. With no difference in the degree of the freedom between two samples, x^2/d.f index was substituted to determine the fit of simultaneous factor model.

The hypothesis of equal covariance structures for SERVQUAL Study Sample 1 and the SERVQUAL Study Sample 2 was rejected, indicating different covariance structures. Thus, we proceeded to test the hypotheses of invariance to find parameters responsible for the different covariance structures. We failed to reject the hypotheses of invariant factor patterns and factor variance (Ho.2 & 3 in Table 1) at the significance level of 5%.

The hypothesis of measurement error invariance between samples (Ho.4 in Table 1) was rejected at the significance level of 1%, indicating the difference in covariance structures between two samples can be mainly explained by random errors of measurement. In sum, this analysis indicates that the refined IS SERVQUAL 13 item short form instrument does measure the same underlying concept of IS service quality for both samples.

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