Confirmatory Factor Analysis of the End–User Computing Satisfaction Instrument: A Replication

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Cross–validation is an important and often neglected step in the scientific process. Measurement models can vary across samples and must be tested and retested before they are accepted as valid. In a review of user satisfaction instruments, Klenke concludes that there is an appalling lack of effort to cross–validate MIS instruments and calls for efforts to retest the End–User Computing Satisfaction (EUCS) instrument using new data. Using different sampling methods and a new sample of 359 respondents, this study replicates an earlier confirmatory factor analysis of the EUCS instrument. This replication suggests that the EUCS instrument is robust (i.e., not affected by sampling methods) and can be used with confidence to evaluate information systems.

User satisfaction is considered one of the most important measures of information systems success (DeLone and McLean, 1992; Ives and Olson, 1984). The structure and dimensionality of the user satisfaction construct are important theoretical issues that have received considerable attention (Zmud, 1978; Larcher and Lessig, 1980; Swanson, 1982; Ives, Olson and Baroudi, 1983; Doll and Torkzadeh, 1988). These issues have not been fully resolved. Most of this literature focuses on explaining what user satisfaction is by identifying its components, but the discussion usually suggests that user satisfaction may be a single construct. Substantive research studies use a total score obtained by summing items (i.e., implying that user satisfaction is a single first–order construct).

Several researchers have stressed the importance of developing standardized instruments for measuring user satisfaction (Ives and Olson, 1984; Straub, 1989; DeLone and McLean, 1992). The research cycle (Mackenzie and House, 1979; McGrath, 1979) for developing a standardized instrument has two steps: (1) exploratory studies that develop hypothesized measurement model(s) via the analysis of empirical data from a referent population; and (2) confirmatory studies that test hypothesized measurement model(s) against new data gathered from the same referent population.

Only a few researchers have devoted serious attention to the measurement of user satisfaction (e.g., Jenkins and Ricketts, 1979; Bailey and Pearson, 1983; Ives, Olson and Baroudi, 1983; Goodhue, 1988; Baroudi and Orlikowski, 1988; Doll and Torkzadeh, 1988). These instrument development efforts have been exploratory studies or replications using exploratory techniques. Confirmatory factor analysis is needed to complete the research cycle; it provides a more rigorous and systematic test of alternative factor structures than is possible within the framework of exploratory factor analysis (Bollen, 1989; Joreskog and Sorbom, 1989).
In an exploratory study, Doll and Torkzadeh (1988) propose an end–user computing satisfaction (EUCS) measurement model that consists of five first–order factors (content, format, accuracy, ease of use, timeliness) measured by 12 items. The instrument is illustrated in the appendix. A single second–order factor is interpreted as EUCS. The first–order factors provide a framework for explaining the EUCS construct by identifying underlying components. Interpretations given to the factors represent post–hoc judgements. Thus, Doll and Torkzadeh’s proposed measurement model is best treated as a hypothesis that must be tested, and retested, before any interpretation of the structure or dimensionality of the EUCS construct is accepted as valid (Klenke, 1992).

Zmud and Boynton (1991) found that the EUCS instrument was one of only three scales (out of 119 scales examined) that met three criteria (i.e., multiple items, reliability, validity) for a well developed instrument. Klenke (1992) concluded that there is an appalling lack of effort to cross–validate MIS instruments. She called for the EUCS instrument to be administered in different samples to establish the invariance (or lack of it) of the reported factor structure.

Using a new sample of 409 respondents, Doll, Xia and Torkzadeh (1994) conducted a confirmatory factor analysis that supported the EUCS instrument. This research gathers additional data using different sampling methods to replicate tests of the structure, validity, and reliability of the EUCS instrument. Replication using new data is an important check on whether the measurement model is robust (i.e., the structure of the measurement model is not a sampling fluke or an artifact of sampling methods). In theory, the importance of replication is widely recognized. In practice replicative studies appear far too infrequently (Bollen, 1989). In the words of Popper (1959), "We do not take even our own observations quite seriously, or accept them as scientific observations, until we have repeated and tested them."

Research Methods

Confirmatory factor analysis involves the specification and estimation of one or more putative models of factor structure, each of which proposes a set of latent variables (factors) to account for covariances among a set of observed variables (Joreskog and Sorbom, 1989; Bagozzi, 1980; Bollen, 1989). It requires a priori designaton of plausible factor patterns from previous theoretical or empirical work. These plausible alternative models are then explicitly tested statistically against sample data. Confirmatory factor analysis has been used extensively in psychology, marketing, and counseling for validating instruments by testing alternative models (e.g., Byrne, 1989; Marsh and Hocevar, 1985; Marsh and Hocevar, 1988; Thacker, Fields and Tetrick, 1989; Marsh, 1985; Harvey, Billings and Nilan, 1985; and Kumar and Sashi, 1989).

In this study, LISREL VIII (Joreskog and Sorbom, 1991) was used to describe alternative models and test the fit of each hypothesized model against the sample data. First, based on logic, theory and previous studies, four plausible alternative models of factor structure are proposed (see Figure 1). Without respecifying the models, model–data fit and evidence of a higher–order factor is assessed using several goodness–of–fit indexes. One model is selected as representing the underlying factor structure in the sample data. Second, confirmatory factor analysis is used to assess the reliability and validity of the factors and items in the selected model.

The Alternative Models

Model 1 hypothesizes one first–order factor (EUCS) accounting for all the common variance among the twelve items. Theory as well as substantive research studies using user satisfaction instruments, including EUCS, typically assume that user satisfaction is a single first–order construct. This assumption is implicit in the typical practice of scaling the satisfaction construct by adding individual items to obtain a total score. Doll and Torkzadeh (1988) scale EUCS by using such a total score, implying that one first–order factor is a plausible model of underlying data structure.

Model 2 hypothesizes that the twelve items form into five uncorrelated or orthogonal first–order factors (content, accuracy, format, ease of use, timeliness). Doll and Torkzadeh's use of varimax (orthogonal) rotation should have resulted in five uncorrelated factors; thus, Model 2 is considered a plausible alternative model of underlying data structure. Examining this model also provides a test of the necessity of incorporating correlated factors by enabling a comparison of the increase in fit between uncorrelated and correlated models.

Model 3 hypothesizes that the five first–order factors are correlated with each other. Doll and Torkzadeh (1988) clearly lay a foundation for this model in their discussion of the large common variance among the 12 items (see page 265). The original study used corrected–item total correlations and correlations with an overall criterion (a global user satisfaction measure) to eliminate items. This elimination method resulted in 12 items that had substantial common variance. The factor scores from a varimax rotation are orthogonal, but the subscales are not necessarily orthogonal (uncorrelated). If the items have a large amount of common variance, scales based on these items may be correlated. This model was not explicitly proposed by Doll and Torkzadeh, yet it is plausible because of common variance among the 12 items.

Model 4 hypothesizes five first–order factors and one second–order factor (EUCS). This model was tested because it was proposed by Doll and Torkzadeh (see Figure 3 on page 268 of their 1988 article). If first–order factors are correlated, it is possible that the correlations between first–order factors is statistically "caused" by a single second–order factor (Tanaka and Huba, 1984).

Criteria for Comparing Model–Data Fit

Because no one statistic is universally accepted as an index of model adequacy, our interpretation of results empha-
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