



## A cross-cultural analysis of the end-user computing satisfaction instrument: A multi-group invariance analysis

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### ABSTRACT

IT managers in global firms often rely on user evaluations to guide their decision-making in adopting, implementing, and monitoring the effectiveness of enterprise systems across national cultures. In these decisions, managers need instruments that provide valid comparisons across cultures. Using samples representing five nations/world regions including the US, Western Europe, Saudi Arabia, India, and Taiwan, we used multi-group invariance analysis to evaluate whether the end-user computing satisfaction (EUCS) instrument (12-item summed scale and five factors) provided equivalent measurement across cultures. The results provided evidence that the EUCS instrument's 12-item scale and the five factors were equivalent across the cultures we examined. The implications of this for the global management of technology are discussed. Knowledge of the equivalence of MIS instruments across national cultures can enhance the MIS cross-cultural research agenda.

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### 1. Introduction

The globalization of business has highlighted the need to understand the effectiveness of information systems that span different nations and cultures. Global organizations have a growing need to utilize IT to achieve economies of scale, coordinate global operations, and facilitate collaborative work across distributed locations and diverse cultures. However, cultural differences can make the difference between success and failure in the adoption and implementation of IS. Despite the importance of cross-cultural studies, no studies of the robustness or measurement equivalence of any of the established information system instruments across national cultures exist. A key problem is thus in ensuring valid cross-cultural comparisons of system effectiveness.

Global IT management and cross-cultural research in MIS often involve comparing samples from two or more cultures on system

success, e.g., user satisfaction/acceptance or system use. A methodological consideration in conducting comparisons focuses on ruling out alternative explanations for differences and, thus, enhancing the interpretability of results. Any observed differences in mean scores across samples give rise to many explanations. Researchers or IT managers may question whether results are true differences due to culture [39] or merely due to measurement artifacts [38]. To make valid comparisons, the instruments must provide equivalent measurement.

Without this, observed scores from different nations or cultures may not be directly comparable. Examining whether scales are comparable is thus necessary to improve our understanding of how culture affects IS success and better manage technology in a global context.

User satisfaction has become a pervasive measure of the success or effectiveness of information systems for both managers and researchers. Originally developed by Doll and Torkzadeh [12] to measure a user's satisfaction with a specific application, the end-user computing satisfaction (EUCS) instrument has been widely used and cross-validated [18,36,43]. While the original instrument is relatively old, the item-factor loadings for the 12-item instrument have been remarkably stable. Gelderman [20] found

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that EUCS was a good predictor of an application's impact on organizational performance and, thus, a useful surrogate for system success.

The EUCS instrument has been validated for today's popular enterprise wide applications [41] that employ standardized software modules with user customizable interfaces. Such applications (e.g., SAP, Oracle, and PeopleSoft) are commonly used by global firms' users in a variety of national cultures.

The EUCS construct is defined as a second-order latent factor consisting of five first-order latent factors (i.e., content, format, accuracy, ease of use, and timeliness). The five first-order latent factors and their structural weights define the meaning of the second-order EUCS construct. The structural weights indicate how central each of the first-order latent factors is to the meaning of the construct [33].

The EUCS instrument's 12-item scale was recently found to provide equivalent measurement (e.g., item-factor loadings) across a wide variety of application types, respondent positions, and hardware platforms [16]. However, the structural weights (loadings of first order factors on second-order EUCS factor) for accuracy and ease of use were found to be variant across user groups and types of applications. Thus, the study found that the EUCS 12-item summed scale and the five component factor scales provided robust (equivalent) measurement across a variety of target populations.

Studies of the cross-cultural measurement equivalence of IS instruments can complement the research of those focusing on how culture affects the design, adoption, implementation, and on-going use of global IS. Tan and Gallupe [42] argued that instruments that are developed and validated in the traditional IS field can be and should be applied to and validated across the global context. The wisdom of the global IT manager's decision to allocate resources to diagnosis and intervention may depend upon robust instruments like EUCS. If the instrument is robust, low user satisfaction scores may indicate a training or implementation process that is poorly designed for a particular location.

Despite the wide use of the EUCS instrument, its validity and measurement equivalence across different cultures has not been examined. Studies that explore the measurement equivalence across national cultures will enhance interpretability of research. Based on five independently collected samples from the US, Taiwan, Western Europe, India, and Saudi Arabia, we used multi-group invariance analysis to explore the degree to which the EUCS instrument provided measurement equivalence across national cultures/world regions.

## 2. The importance of measurement invariance across culture

If the Director of MIS of an international firm can compare user satisfaction scores for an application across cultures, he or she may be able to identify problems areas where user satisfaction is low, diagnose the nature and cause of the problem, and take corrective action. Yet, there are many well-known problems associated with conducting cross-national research [21].

When designing cross-cultural studies to evaluate IS, both researchers and practitioners need to know whether user satisfaction has equivalent measurement across national cultures in their firm or sample. Evaluation and diagnostic instruments that provide equivalent measurement across national cultures are particularly valuable to multinational firms who seek to leverage technology across countries/cultures. Such studies later work in benchmarking [15].

The global management of IT requires comparative studies of both the systems development process and the post-implemen-

tion evaluation of IS. The development process is complex and highly context dependent. Ives and Jarvenpaa [28] contended that the context of the development process depended on the firm's global business strategy, the IS platforms in each country, international data sharing regulations, and cultural differences. Studying the systems development process involved behavioral observations of a dynamically changing process (e.g., user participation, stages, and methods) that may have different meanings across cultures. Cultural studies may therefore be challenging and sometimes the interpretation of results may not be equivocal.

The ongoing evaluation of user satisfaction with a system occurs in a more stable context (routine work flow); the system has often had to be adapted to meet local requirements, business goals, hardware platforms, or infrastructures; users have had to gain experience in using the systems to meet their needs. In this more stable context, lack of measurement equivalence may be attributed to culture.

A fundamental, unresolved issue with multinational research is whether similarities or differences are, in fact, real [4]. Standardized instruments must provide equivalent (invariant) measurement across national cultures (equal true scores) if comparative statements across cultures are to have substantive import. Drasgow and Kanfer [19] argued that without equivalent measures, observed scores from different cultures were on different scales and, therefore, were not comparable.

For example, to compare EUCS scores from India and the US, the 12 items comprising the EUCS instrument must have the same amount of trait or true scores in both countries. The formula relating trait and error for each item of the 12 items is  $x = \lambda\xi + \varepsilon$ , where  $x$  is the observed score for the item on a 1–5 Likert scale,  $\lambda$  is slope of the regression of the observed score on the true score,  $\xi$  is the true score, and  $\varepsilon$  is the error term. For observed scores in India and the US to be equivalent,  $\lambda$  values for each of the 12 items must be statistically equivalent for both India and the US (i.e.,  $\lambda_{1, \text{India}} = \lambda_{1, \text{US}}$ ,  $\lambda_{2, \text{India}} = \lambda_{2, \text{US}}$ , ...,  $\lambda_{12, \text{India}} = \lambda_{12, \text{US}}$ ). If this rather stringent condition is not met, we do not know whether an observed difference for the 12-item summed scale of the EUCS instrument is real or a measurement artifact of cultural differences between the countries.

If the  $\lambda$ s for India are systematically smaller than those for the US, the mean score on the 12-item summed EUCS scale would tend to suggest that the respondents from Indian respondents have lower user satisfaction than US respondents, even if both groups have the same true satisfaction level. Correlations between EUCS 12-item scores and correlates such as usage (e.g., hours, extent, etc.), training, or support would also appear to be lower in the Indian sample than in the US sample. MIS managers with global responsibility might mistakenly conclude that satisfaction has a lower correlation with usage in India than in the US. These managers might also mistakenly conclude that user training or support is not as effective at improving satisfaction in India. However, these lower correlations would be an artifact of cultural differences in measurement. These issues were discussed further by Bollen [6].

### 2.1. Research on the EUCS instrument

The EUCS instrument has been used in different cultural contexts: by Igbaria and Tan [27] in Singapore, by Doll and Torkzadeh [13] in the US, by McHaney et al. [37] in Taiwan, by Gelderman in the Netherlands, and by Al-Gahtani and King [1] in Great Britain. However, we know little about the accuracy of the EUCS for cross-cultural system evaluations in enterprise wide applications across the globe. The question of cross-cultural measurement invariance is not whether national culture affects

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