Information Systems Research

Publication details, including instructions for authors and subscription information:
http://pubsonline.informs.org

Assessing the Validity of IS Success Models: An Empirical Test and Theoretical Analysis

Arun Rai, Sandra S. Lang, Robert B. Welker,

To cite this article:
Arun Rai, Sandra S. Lang, Robert B. Welker, (2002) Assessing the Validity of IS Success Models: An Empirical Test and Theoretical Analysis. Information Systems Research 13(1):50-69. https://doi.org/10.1287/isre.13.1.50.96

Assessing the Validity of IS Success Models: An Empirical Test and Theoretical Analysis

Arun Rai • Sandra S. Lang • Robert B. Welker
Electronic Commerce Institute, Robinson College of Business, Georgia State University, Atlanta, Georgia 30303
McKendree College, Division of Business, Lebanon, Illinois 62254
School of Accountancy, Southern Illinois University at Carbondale, Carbondale, Illinois 62901
arunrai@gsu.edu • sslang@mckendree.edu • welker@cba.siu.edu

The purpose of the present study is to empirically and theoretically assess DeLone and McLean's (1992) and Seddon's (1997) models of information systems (IS) success in a quasi-voluntary IS use context. Structural modeling techniques were applied to data collected by questionnaire from 274 system users of an integrated student information system at a midwestern university. The Seddon structural model and the DeLone and McLean structural model each contained five variables (system quality, information quality, perceived usefulness, user satisfaction, and IS use). Both models exhibit reasonable fit with the collected data. The empirical findings are assessed in the broader theoretical context of the IS success literature, including the Technology Acceptance Model and the Theory of Planned Behavior. Our results support DeLone and McLean's focus on integrated IS success models and their observation that IS success models need to be carefully specified in a given context. The Seddon model conceptually elaborates and clarifies aspects of the DeLone and McLean model, thereby effectively integrating core theoretical relationships espoused in the IS success literature. Our study also supports Seddon's three construct categories (system and information quality, general perceptual measures about net benefits about IS use, and IS behavior), as defining IS success and its impact on nature of IS use.
(*Information Systems Success*; *Information Systems Usefulness*; *Information Systems Use*; *User Satisfaction*; *System Quality*; *Information Quality*)

Introduction

The concept of IS success is widely accepted throughout IS research as the principal criterion for evaluating information systems. Theorists, however, are still grappling with the question of which constructs best represent IS success. The problem lies in the ambiguity of the concept and the multiplicity of IS success constructs pervading the research. To wit, DeLone and McLean (1992) identified over 100 measures utilized in the 180 studies they reviewed. With such fragmentation, it is difficult to assess how studies interrelate. The existence of this chaotic environment has led to a quest for a unifying taxonomy that can be applied in the selection of IS success constructs for study. Kim (1989), for instance, constructed a relational model to provide coherent structure to the concept of user satisfaction, a concept that has been applied frequently as a surrogate for IS success. In a comprehensive attempt to introduce order, DeLone and McLean (1992) synthesized a six-factor taxonomy of IS success from the diversity of IS success measures contained in the studies they reviewed. The categories of the taxonomy are System Quality, Information Quality, IS Use, User Satisfaction, Individual Impact, and Organization Impact.

DeLone and McLean (1992) proffered a relational model that interrelates the six variable categories. This

1047-7047/02/1301/0050$05.00
1526-5536 electronic ISSN

model was constructed largely on the basis of Mason (1978). DeLone and McLean do not provide empirical validation of the model and, in fact, suggest further development and validation is needed for their taxonomy (DeLone and McLean 1992). Seddon (1997) believes that DeLone and McLean's model is too encompassing and introduces some confusion because it mixes process and causal explanations of IS success. He points out that IS Use in the DeLone and McLean model has three possible meanings. His model treats IS Use as a behavior, as opposed to a proxy for benefits or an event in a process leading to individual or organizational impact. He proposes an alternative model that focuses on the variance (causal) aspects of the interrelationships among the taxonomic categories.[1] His model considers three classes of variables: measures of information and system quality, general measures of net benefits of IS use, and behavior with respect to IS use. It is by no means clear how IS researchers should respond to this controversy. Are the two models both valid, only one, or neither? Or, are variations on either model more representative of real-world user behavior?

Whereas it would be useful to compare the models to see which is superior, it is nearly impossible to do so, particularly in the context of the present study. Our empirical investigation considers *quasi-volitional* IS use of a single application system introduced at one large organization. In addition, the single organization setting precludes examining certain classes of variables, such as organizational impact, that are part of the models. The quasi-volitional nature of IS use constrains a direct comparison of the models, as the DeLone and McLean model assumes volitional usage, whereas the Seddon model is developed for both volitional and nonvolitional usage contexts. Even without a direct comparison of the models, is there evidence that lends credibility, independently, to the viability of each model?

The present study examines the validity of the DeLone and McLean and Seddon models. Both models integrate and interrelate multiple dimensions of IS Success. The two models have several commonalities and some important distinctions. The two models are specified and tested in a *quasi-volitional* IS use context regarding a Student Information System (SIS) in place at a large state university. The empirical evidence and well-established IS success theories, including the Technology Acceptance Model and Theory of Planned Behavior, are used to assess the theoretical tenets of each model. Implications for future research are also discussed.

Background

Elements of DeLone and McLean's model have been tested previously. For instance, Hunton and Flowers (1997) and Seddon and Kiew (1994) have tested the relationships between categories of DeLone and McLean's taxonomy. The constructs studied by these authors and summaries of their results are presented in Table 1.

In general, Hunton and Flowers (1997) and Seddon and Kiew (1994) found support for the relationships of the DeLone and McLean model. For comparison purposes, the first column of Table 1 lists the nine categorical relationships of the DeLone and McLean model. Hunton and Flowers found support for seven of the nine relationships. The two with insignificant relationships were from IS Use to User Satisfaction and from User Satisfaction to Individual Impact. Their fit statistics were above generally accepted norms, suggesting reasonable fit with their data. Seddon and Kiew tested five of the nine relationships and found each to be significant. In contrast with Hunton and Flowers, Seddon and Kiew found a significant path from Usefulness (alternative for Use) to User Satisfaction. This disparity in findings may be due to differences in the constructs used to represent DeLone and McLean's taxonomic categories.

Seddon (1997) identifies three distinct models intermingled in DeLone and McLean's model, each reflecting a different interpretation of IS Use. One is a process

[1]It should be noted that other IS researchers propose refinements to DeLone and McLean's taxonomy. For instance, Ballantine et al. (1996), and Myers et al. (1997) propose new boundaries for existing categories, new categories, and new elements within categories. Ballantine et al. (1996) expand DeLone and McLean's taxonomy by separating IS effectiveness into three fundamental dimensions, and interspersing filters—environmental, integration, and implementation—between these dimensions. Myers et al. (1997) introduce a work group dimension to the model. This emerging body of literature continues to draw upon DeLone and McLean's taxonomy as the basis for developing theory.

Table 1 Taxonomic Structure

DeLone and McLean Category[1]			Hunton and Flowers Construct[2]			Seddon and Kiew Construct[3]		
From	→	To	From	→	To	From	→	To
Use	→	Individual Impact	Environ Uncertainty (Ge) and Breadth (Z)	→	Job Sat (Sm) and Org Commit (B&A)			
Information Quality	→	Use	Information Quality (D&T)	→	Environ Uncertainty (Ge) and Breadth (Z)	Information Quality (D&T)	→	Usefulness (Davis)
System Quality	→	Satisfaction	Sys Reliab (S) and Ease of Use (D&T)	→	Interface Sat (T&W) and Overall Sat (D&T)	Ease of Use (D&T & Davis)	→	Satisfaction (S&Y)
System Quality	→	Use	Sys Reliab (S) and Ease of Use (D&T)	→	Environ Uncertainty (Ge) and Breadth (Z)	Ease of Use (D&T & Davis)	→	Usefulness (Davis)
Information Quality	→	Satisfaction	Information Quality (D&T)	→	Interface Sat (T&W) and Overall Sat (D&T)	Information Quality (D&T)	→	Satisfaction (S&Y)
System Quality	→	Information Quality	Sys Reliab (S) and Ease of Use (D&T)	→	Information Quality (D&T)			
Satisfaction	→	Use	Interface Sat (T&W) and Overall Sat (D&T)	→	Environ Uncertainty (Ge) and Breadth (Z)			
Use	→	Satisfaction	Environ Uncertainty (Ge) and Breadth (Z)	→	Interface Sat (T&W) and Overall Sat (D&T)	Usefulness (Davis)	→	Satisfaction (S&Y)
Satisfaction	→	Individual Impact	Interface Sat (T&W) and Overall Sat (D&T)	→	Job Sat (Sm) and Org Commit (B&A)			

Note.

B & A = Broadfoot and Ashkanasy (1994)

Davis (1989)

D & T = Doll and Torkzadeh (1988)

Ge = Gerloff et al. (1991)

S = Srinivasan (1985)

S & Y = Seddon and Yip (1992)

Sm = Smith, et al. (1969)

T & W = Taylor and Wang (1987)

Z = Zmud et al. (1987)

[1] DeLone and McLean did not propose a specific link from System Quality to Information Quality.

[2] Shaded cells represent statistically insignificant relationships.

[3] Seddon and Kiew considered Usefulness (Davis) as representing the Use category.

The present study treated Usefulness as representing the Individual Impact category.

model of IS success that depicts the sequence of events relating to an IS. DeLone and McLean's (1992) definition of IS Use as the consumption of IS output is consistent with a process model of IS success. A second embedded model is a representation of the behavior that manifests as a result of IS success. In this model, IS Use is a behavior that a person enters into with the expectation of positive outcomes, and as a result, it is a consequence of IS success rather than an integral part of an IS success model. A third embedded model is a variance model of IS success, which links System Quality and Information Quality with surrogate measures of the net benefits that accrue from IS use. In this model, variance in System Quality or variance in Information Quality is a necessary and sufficient antecedent, *ceteris paribus,* to cause variance in perceptual measures of net benefits, namely perceived usefulness of the IS in the past and user satisfaction with the IS.

Seddon's argument is that the intermingling of the three models in one model of IS success creates confusion concerning the interpretation of boxes and arrows in the DeLone and McLean model. In some cases, boxes and arrows suggest a process interpretation and in other cases they suggest a causal interpretation. To more clearly represent IS success, Seddon (1997) disentangles the process model from the variance models and separates the variance model of IS success from a variance model of behaviors that occur as a result of IS success. In the variance model of IS success, System Quality, Information Quality, and net benefits of IS Use to individuals, organizations, and society have a direct causal connection with two perceptual measures of net benefits, Perceived Usefulness and User Satisfaction. Perceived Usefulness has a direct causal connection with User Satisfaction. In turn, User Satisfaction is linked to a behavioral measure of IS Use indirectly through revised expectations concerning the net benefits that will accrue from future IS use. Expectations concerning net benefits and IS Use (a behavior) reside externally to the IS success model.

Perceived Usefulness is similar to Davis' (1989) measure of perceived usefulness. However, Davis' measurement of perceived usefulness is future oriented. It relates to expectations concerning net benefits and would reside outside of Seddon's variance model of IS success. Perceived usefulness in Seddon's model relates to attitudes that derive from perceptions of net benefits gained from past IS use. In this way, it provides a surrogate measure of actualized net benefits.

Alternative IS Success Models

Context of the Study

The focus of this study is on users of a computerized student information system (SIS) in place at a midwestern university. SIS provides online access to a database of students' personal and academic information. Its use is restricted to authorized faculty, administrators, and office personnel. Access to information delivered by SIS is necessary for many tasks performed by users, but the university *does not mandate* SIS use. Traditional channels to obtain information, albeit procedurally cumbersome, are available to users.

Moore and Benbasat (1996) note that while the degree of voluntariness of IT use is determined by perceived formal requirements for IT use, social norms refer to the perceived social pressure for IT use. Subjective norms establish informal requirements for IT use, while voluntariness pertains to the individual's perception of their power to perform, or not perform, a certain behavior. In our case, while SIS use is not mandated, perceptions of formal requirements and subjective norms create a context where usage is not completely volitional.

We identify four reasons which suggest that our present context represents quasi-volitional IT use. First, when an individual is given authorization to access SIS, it is because the job description requires using the information available through SIS for the conduct of the job. However, the job description does not mandate that the SIS be used as the channel to obtain the information required for the conduct of the job. Second, the task of securing the information by other avenues, albeit an option for the user, is time consuming and burdensome. To obtain the information, users have to go in person to a central location with appropriate written authorization and submit a request for the information. The complexity of the procedure, including written authorization requirement, sends a signal to users that they should consider using the SIS system. Third,

users can use intermediaries to interface with SIS. Faculty and administrators can request authorized staff members to retrieve required information from SIS and, conceivably, staff members can request other authorized staff members to do so as well. Fourth, as suggested by Moore and Benbasat (1996) and Igbaria et al. (1995), even if use is not mandated, social pressure may compel system use. For instance, while using intermediaries is feasible, it would be embarrassing for an individual to ask another authorized person to gather the information when that person has the authorization to access SIS directly. Also, coworkers and supervisors could view it as a poor use of time.

In summary, users are not mandated to use the particular system in the present study, as alternate channels are available for them to obtain information for their jobs. Yet, the signals sent through the complexity associated with using alternate channels, coupled with the social pressures associated with expectations of use, suggest that our context is best classified as representing quasi-volitional IT use.

DeLone and McLean note that the multidimensional and interdependent nature of IS success requires careful attention to the definition and measurement of each aspect of their model. Selection of success dimensions and measures should be contingent on the context of the empirical investigation.

There has been specific discussion in the literature pertaining to measurement of IS use, which has been employed as a measure of IS success in numerous studies (e.g., Davis 1989, Goodhue 1995, Igbaria et al. 1995, Seddon and Yip 1992). It has been measured in various ways, including computerized logs of actual use (Straub et al. 1995), estimates of actual use (Adams et al. 1992, Thompson et al. 1994), estimates of frequency of use (Davis 1989, Hartwick and Barki 1994, Igbaria et al. 1995), and dependence on the system (Goodhue and Thompson 1995). Seddon states, ". . . for voluntary use, of similar systems, by similarly skilled users, measures of *IS Use* (such as hours of use and frequency of use) can act as proxies for *Benefits from Use*" (1997, p. 243, emphasis his).

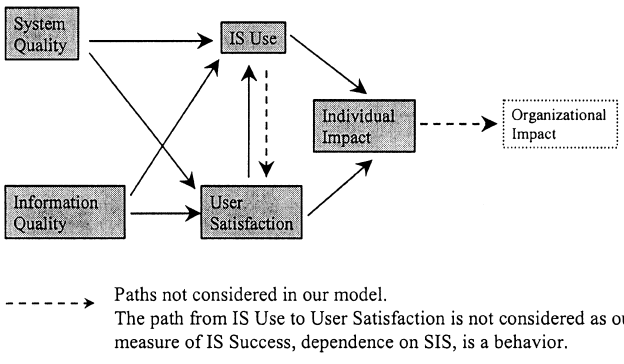
Goodhue and Thompson (1995) note that if the conceptualization of utilization behavior is grounded in reference disciplines pertaining to attitudes and behavior, measures such as hours of use and frequency of use can be problematic. While the decision to use the system is impacted by attitudes and beliefs, variations in hours of use or frequency of use can be a consequence of the size of the task or task-technology fit. Given the difficulty in empirically observing the proportion of times users choose to use a system, they note that utilization is well reflected by, "the extent to which the information system has been integrated into each individual's work routines" (p. 223). As more information is consumed to fulfill job requirements, the more the information system is integrated into the user's work routine, and the more dependent the person becomes on the system (e.g., Goodhue and Thompson, 1995). Accordingly, IS use was assessed in terms of user dependence on SIS.

The two models that were tested are reproduced in Figures 1 and 2. Each model includes the taxonomic categories of System Quality, Information Quality, User Satisfaction, and IS Use. Each also includes an additional variable, Perceived Usefulness, that DeLone and McLean did not include in their taxonomy, but which is an integral component of Seddon's model. Organization Impact and Societal Impact variables were not studied because data were collected in a single organization. The figures show the models examined and indicate elements of each model not considered.

The DeLone and McLean Model

In the DeLone and McLean model (Figure 1), System Quality and Information Quality are depicted as affecting both IS Use and User Satisfaction, which in turn are direct antecedents of Individual Impact. DeLone

Figure 1 DeLone and McLean Model



and McLean (e.g., 1992, Figure 1, p. 62) conceptualize their model in terms of the ideas proffered by Shannon and Weaver (1949) and Mason (1978). Shannon and Weaver (1949) group communication problems into three hierarchical levels: a technical level, a semantic level, and an effectiveness level. The technical level concerns how well the system transfers the symbols of communication, the semantic level concerns the interpretation of meaning by the receiver as compared with the intended meaning of the sender, and the effectiveness level relates to how well the meaning conveyed to the receiver affects actual behavior. Mason adapted Shannon and Weaver's three levels of communication problems to an IS context. Mason interpreted the effectiveness level to include influence on users and defined the effectiveness-influence level in terms of events that may influence users. The events include receipt of information, evaluation of information, and application of information. Evaluation and application of information may effect a change in the user's behavior.

In terms of DeLone and McLean's taxonomy, System Quality belongs to the technical level, and Information Quality belongs to the semantic level. IS Use, User Satisfaction, and Individual Impact belong to the effectiveness-influence level. The hierarchy of levels provide a basis for modeling System Quality and Information Quality as antecedents of IS Use, User Satisfaction, and Individual Impact. DeLone and McLean (1992) applied Mason's arguments to model Use and User Satisfaction (response to use of IS output) as antecedents of Individual Impact (effect of information on behavior).

A core aspect of the DeLone and McLean model is that Use is considered as an IS success variable, and consequently is included in their IS success model. They label IS Use as the consumption of IS output (1992), which they consider to be a precursor of Individual Impact. As per their model, IS Use is required to significantly impact realization of system benefits.

DeLone and McLean note the importance of specifying the dimensions of IS success and associated relationships carefully in a given context. In our case, User Satisfaction impacts IS Use, as a higher level of satisfaction builds greater user dependence on the system. However, we do not specify a causal path from IS Use to User Satisfaction. The measure of IS Use considered here, dependence on SIS, is a behavior. Our specification of the relationship between User Satisfaction and IS Use (dependence on the system) is consistent with the Technology Acceptance Model, Theory of Planned Behavior, and the system to value chain proposed by Torkzadeh and Doll (1991), which suggest that attitudes impact behavior.

In order to include Perceived Usefulness in the DeLone and McLean model, we had to decide which category in their taxonomy it represents. Although DeLone and McLean did not include Perceived Usefulness in their taxonomy, we make the assumption that Perceived Usefulness is associated with the taxonomic category, Individual Impact. On face, the measure has parallels with "personal valuation of IS," which DeLone and McLean include under the Individual Impact category. Perceptions of usefulness derive from personal valuations of an IS. The measure also relates directly to several additional constructs (e.g., improved individual productivity, task performance, individual power or influence) within the Individual Impact category that relate to aspects of job performance, a key component of perceived usefulness as conceptualized by Seddon (1997) or Davis (1989).

Moreover, Perceived Usefulness, which is a global measure of a user's perception, does not appear to conform well with other characteristics of DeLone and McLean's categories. The categories System Quality and Information Quality relate to *specific* qualities of the system or information generated by the system, and the categories User Satisfaction and IS Use are not defined in terms of a perception. While usefulness may be perceived, in part, from the effect that the IS has on the organization and society, the measure relates specifically to users, and thus is more consistent with the Individual Impact category than either the Organizational Impact category or the Societal Impact category. As a result of this reasoning, Perceived Usefulness is positioned in the DeLone and McLean model as an Individual Impact.

The Seddon Model

The Seddon model is presented in Figure 2.

A principal difference between Seddon's and DeLone and McLean's model is the definition and placement

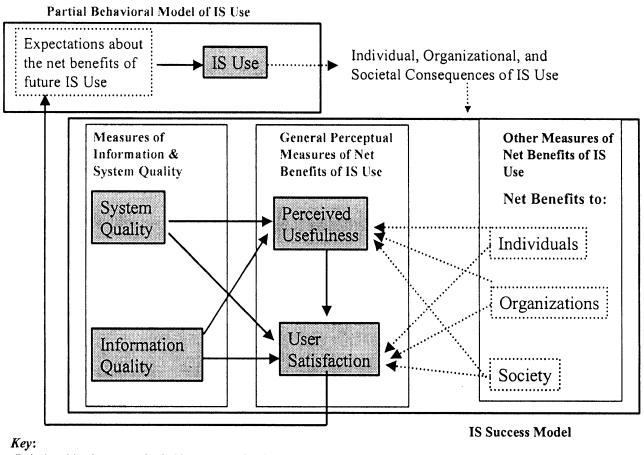
of IS Use. Seddon argues that use must precede impacts and benefits, but it does not cause them. Seddon (1997) considers IS Use to be a behavior that reflects an expectation of net benefits from using an information system and therefore models IS Use as a resulting behavior of IS success. This alternative definition of IS Use suggests that IS Use is a consequence of IS success, rather than being an inherent characteristic of IS success. Accordingly, IS Use as a behavior is separated from the IS Success Model, and IS related behavior is modeled as caused by IS success. This leads to three classes of interrelated variables. The first two classes of variables—information and system quality and perceptions of net benefits of IS Use—constitute the IS Success model, while a third class of variables focuses on IS Use as a behavior and constitutes the Partial Behavior Model of IS Use.

The model contains a direct path leading from System Quality and Information Quality to both Perceived Usefulness and User Satisfaction. Perceived Usefulness impacts User Satisfaction. The IS Success Model and the Partial Behavior Model of IS Use are linked by a path from User Satisfaction to Expectations of Net Benefits from Future IS Use, which, in turn, impacts IS Use. In our case, we assess the direct impact of User Satisfaction on IS Use, as we did not assess Expectations of Net Benefits from Future IS Use.

Research Methods

The paper utilizes a field study methodology and a questionnaire-based data-gathering technique, as per definitions in Boudreau et al. (2001). The questionnaires were distributed to users of a computerized student information system (SIS) in place at a midwestern university. SIS provides online access to a database of student personal and academic information. Its use is restricted to authorized faculty, administrators, and office personnel. For measurement purposes, a category of DeLone and McLean's taxonomy was represented in terms of a single construct, selected from those that comprised the set in DeLone and McLean's taxonomy. A criterion for selection of constructs is that they have been employed frequently in IS research as a measure of IS success. The specific constructs included for measurement in the questionnaires are summarized in Table 2 and discussed subsequently.

Figure 2 Seddon's Model



System Quality

System Quality has been represented in prior research by ease of use, which is defined as the degree to which a system is "user friendly" (Doll and Torkzadeh 1988, p. 259). Adams et al. (1992), Chin and Todd (1995), Davis (1989), Hendrickson et al. (1993), and Segars and Grover (1993) studied ease of use as a measure of IS success. The following two items, selected from Doll and Torkzadeh's (1988) user satisfaction instrument and adapted to specify the SIS application, were used to measure System Quality in this study: "Is SIS user friendly?" and "Is SIS easy to use?" Doll and Torkzadeh found a reliability alpha of 0.85 for the two items. Responses were measured with a five-point scale (1 = almost never, 2 = some of the time, 3 = about half of the time, 4 = most of the time, and 5 = almost always). Higher item scores indicate greater ease of use, and hence, greater system quality.

Information Quality

Information quality was measured in terms of a seven-item scale that captures the degree with which SIS-generated information possesses three attributes: content, accuracy, and format. These attributes represent some of the most extensively studied attributes of information in the IS research literature (e.g., Bailey and Pearson 1983, Baroudi and Orlikowski 1988, Magal 1991, Myers et al. 1997, Rainer and Watson 1995, Seddon and Yip 1992). The items used in the scale are listed in Table 2.

Table 2 Construct Definitions and Measures

Construct	Definition	Variable Category: DeLone and McLean	Variable Category: Seddon	Measurement Items
Information Quality	The degree to which information produced has the attributes of content, accuracy, and format required by the user	Measures of Information Quality	Measures of Information Quality	IQ1. Does SIS provide the precise information you need? IQ2. Does SIS provide output that is exactly what you need? IQ3. Does SIS provide sufficient information to enable you to do your tasks? IQ4. Does SIS have errors in the program that you must work around? IQ5. Are you satisfied with the accuracy of SIS? IQ6. Are the output options (print types, page sizes allowed for, etc.) sufficient for your use? IQ7: Is the information provided helpful regarding your questions or problems?
Ease of Use	The degree to which the SIS easy to use	Measures of System Quality	Measures of System Quality	EOU1. Is SIS user friendly? EOU2. Is SIS easy to use?
Perceived Usefulness	The degree to which the user believes that using a particular system *has* enhanced his or her job performance	Individual Impact	Perceptual measures of net benefits from IS Use	PU1. Using SIS enables me to accomplish student-related tasks more quickly. PU2. Using SIS improves my job performance. PU3. Using SIS in my job increases my productivity. PU4. Using SIS enhances my effectiveness on the job. PU5. Using SIS makes it easier to do my job. PU6. I find SIS useful on my job.
User Satisfaction	The degree of user satisfaction with the system	User Satisfaction	Perceptual measures of net benefits from IS Use	How would you rate your satisfaction with SIS?
Utilization	The degree to which the user is dependent on the IS for the execution of their tasks.	IS Use	IS Use as a Behavior	I am dependent on SIS

Each item was patterned after items used by Doll and Torkzadeh (1988). The first four items were taken directly from Doll and Torkzadeh. In each item, SIS replaced the term, "the system." In Item 2, the phrase "provide reports" was changed to the phrase "provide output," as SIS does not necessarily provide reports. Item 3 was expanded by the phrase "to enable you to do your tasks" to better link the item to the relevancy of the information generated. We constructed Items 5, 6, and 7 to capture the essence of Doll and Torkzadeh's items, but to make them more interpretable in the context of SIS. Interviews with users of SIS revealed confusion relating to broad terms (e.g., accurate, useful format, and clear) that Doll and Torkzadeh used for several of their items. As a result, we rewrote the items to enhance their specificity.

The models that were tested did not include content, accuracy, and format as separate constructs, but the seven items were treated as a single scale to measure the construct of information quality. While Doll and Torkzadeh (1988) studied content, accuracy, and format as separate constructs, they found high pairwise correlations (ranging from 0.41 to 0.68) among the three constructs. We observed high pairwise correlations

that suggest that these three facets encompass a single latency, that of information quality. Furthermore, our confirmatory factor analysis of this measure supported a single latency representation of the seven measurement items. On this basis, we concluded that items making up each scale could be assembled into a single scale that possesses acceptable internal reliability. Responses were made on a five-point scale (1 = almost never, 2 = some of the time, 3 = about half of the time, 4 = most of the time, and 5 = almost always). Each item was coded in such a way that higher scores indicate greater information quality.

IS Use

Utilization of SIS was assessed with a single item based on the Goodhue and Thompson dependence measure. The item was adapted slightly to fit a SIS context. Respondents indicated their dependence on SIS on a five-point response scale, with higher scores indicating greater dependence.

User Satisfaction

User Satisfaction was traditionally employed as a label of IS success (Bailey and Pearson 1983), and therefore frequently measured in past studies. In fact, DeLone and McLean tabulate 39 studies that empirically measure user satisfaction. Bailey and Pearson (1983) stated, ". . . satisfaction in a given situation is the sum of one's feelings or attitudes toward a variety of factors affecting that situation." (p. 531). It has been measured indirectly through information quality, system quality, and other variables. In such situations, a single-item overall measure has been employed to which to compare the indirect surrogates of satisfaction (Doll and Torkzadeh 1988, Torkzadeh and Doll 1991, Hendrickson et al. 1994, Doll et al. 1994). The concept of IS success has been refined in the context of integrated IS success models, including the DeLone and McLean and Seddon models, to develop causal relations between indirect measures of User Satisfaction, such as system quality and information quality, and overall level of User Satisfaction.

Baroudi and Orlikowski (1988) developed a shorter version of the 39-scale user satisfaction instrument developed by Ives et al. (1983). Based on their empirical analysis, they note that a single-item measure of user satisfaction can be conveniently used when only an overall indication of user information satisfaction is desired, with no interest in particular areas of content or discontent. Given our interest in capturing a global measure of user satisfaction with SIS and concerns about survey length and respondent convenience, we measured User Satisfaction with a single item (How would you rate your satisfaction with SIS?). This single-item global measure enables a reasonable assessment of SIS usage variations in the current context. Respondents rated their satisfaction with SIS on a five-point scale ranging from nonexistent to complete, with higher scores indicating greater satisfaction.

Perceived Usefulness

Perceived Usefulness is defined by Seddon (1997, Table 1) as "the degree to which the stakeholder believes that using a particular system *has* enhanced his or her job performance, or his or her group's or organization's performance" (emphasis his). Perceived Usefulness was measured with a six-item scale developed by Davis (1989). Each item was adapted to specifically reference SIS. In addition, the future-orientation of Davis's instrument was changed to better reflect past usage. Example items include: "Using SIS in my job increases my productivity," and "Using SIS enhances my effectiveness on the job." Ratings were made on a seven-point scale (1 = extremely likely, 2 = quite likely, 3 = slightly likely, 4 = neither, 5 = slightly unlikely, 6 = quite unlikely, and 7 = extremely unlikely). Items were coded such that higher values indicate greater Perceived Usefulness.

Sample

Questionnaires were distributed to an initial population of the 908 university personnel authorized to access SIS. The population included every employee listed on a university database of authorized users, which included faculty, staff, and administrators. Students are not authorized to access the system. Of the population of 908 potential users, 274 usable questionnaires were returned, representing a response rate of 30%.

Nonresponse bias can occur in survey research, and researchers are advised to examine for the existence of this bias in their data (Bailey 1978, Straub 1989). As recommended by Armstrong and Overton (1977), to

test for nonresponse bias early responders were compared with late responders in terms of variables under study. No significant differences in means were found (multivariate analysis of variance, Wilke's Lambda = 0.96, F (5,139) = 1.20, p = 0.31). In addition, the sample was compared with the population in terms of gender. Female employees comprised 71% of the population and 74% of the sample, a difference that is not statistically significant ($\chi^2(1) = 2.13$, n.s.). Respondents ranged from 18 to 66 years of age, with a mean age of 38.7 (sd = 11.7). Tenure at the university ranged from 8 months to 34 years, with mean tenure of 9.76 years (sd = 8.0).

Our sample represents diversity on important demographic factors, such as age, organizational tenure, and gender. It contains a larger proportion of female respondents (74%). The university has multiple colleges, departments, and administrative units, and, as is typical of large universities, these units are fairly autonomous and diverse in their personnel makeup. These characteristics of our sample suggest that the study's external validity is not limited to the present data collection context.

Analysis and Results

Confirmatory factor analysis of multiple-item scales and the estimation of fit indices for the structural models were performed with the LISREL 8 computer package (Joreskog and Sorbom 1993). Each of the 17 response items was allowed to load only on its associated latent variable. We used Likert-type scales, with each item having more than three values for its measurement, a condition which West et al. (1995) consider essential for treating items as continuous variables in the LISREL analysis. As a consequence, response items were assumed for analysis purposes to be measured on continuous scales. LISREL models were estimated with a covariance matrix and the maximum-likelihood estimation method. The maximum-likelihood estimation method has been found to provide good parameter estimates even when the data deviate moderately from a normal distribution (Chou and Bentler 1995). West et al. (1995) establish an absolute value of two for univariate skewness and seven for univariate kurtosis as maximum limits for acceptable departures from normality. With the exception of one of the usefulness items, which had a skewness of 2.2, all other items were within the recommended limits in terms of skewness (ranging from 0.477 to 1.965) and kurtosis (ranging from 0.102 to 6.750). The univariate statistics were computed with PRELIS (Joreskog and Sorbom 1993). For each latent variable, the loading of one item was set to equal 1.00, which prompts LISREL to generate loadings for other items in terms of a common scale. The error variance of single-item scales was set to zero.

Descriptive Statistics

Means, standard deviations, and ranges for the latent variables are reported in Part A of Table 3. To compute these descriptive statistics, multiple-item scales were summed and averaged. Squared pairwise correlations between latent variables, computed with LISREL, are reported in Part B of Table 3. Alpha reliability (Cronbach's alpha) estimates for the multiple-item scales are reported on the main diagonal of the table. Each alpha exceeds the minimum acceptable level of 0.70 recommended by Nunnally (1967).

Table 3a Means, Standard Deviations, and Ranges

Variable	Mean	SD	Min	Max
Perceived Usefulness	6.2	1.0	1	7
User Satisfaction	3.9	0.7	1	5
IS Use: Dependence	2.4	1.5	1	5
Information Quality	4.0	0.9	1	5
System Quality	3.4	1.2	1	5

Table 3b Squared Pairwise Correlations and Alpha Internal Reliabilities

Variable	PU	S	D	IQ	SQ
Perceived Usefulness (PU)	0.96				
User Satisfaction (S)	0.37	NA			
IS Use: Dependence (D)	0.51	0.27	NA		
Information Quality (IQ)	0.36	0.45	0.21	0.86	
System Quality (SQ)	0.23	0.30	0.14	0.24	0.92

Note. Alpha internal reliability coefficients (Cronbach's alphas) for the multiple-item scales are shown on the main diagonal. Squared pairwise correlations were computed with LISREL. Squared pairwise correlations above 0.11 are significant at $p < 0.05$.

Table 4 Results of Confirmatory Factory Analysis

Construct	Measurement Items	Std. Loading	Composite Reliability	Variance-Extracted Estimate
Information Quality	(1) Does SIS provide the precise information you need?	0.88		
	(2) Does SIS provide output that is exactly what you need?	0.89		
	(3) Does SIS provide sufficient information to enable you to do your tasks?	0.85		
	(4) Does SIS have errors in the program that you must work around?	0.49	0.88	0.52
	(5) Are you satisfied with the accuracy of SIS?	0.67		
	(6) Are the output options (print types, page sizes allowed for, etc.) sufficient for your use?	0.45		
	(7) Is the information provided helpful regarding your questions or problems?	0.67		
Ease of Use	(1) Is SIS user friendly?	0.90	0.92	0.85
	(2) Is SIS easy to use?	0.94		
Perceived Usefulness	(1) Using SIS enables me to accomplish student-related tasks more quickly.	0.80		
	(2) Using SIS improves my job performance.	0.89		
	(3) Using SIS in my job increases my productivity.	0.94	0.96	0.79
	(4) Using SIS enhances my effectiveness on the job.	0.94		
	(5) Using SIS makes it easier to do my job.	0.88		
	(6) I find SIS useful on my job.	0.88		

Measurement Properties of Multiple-Item Scales

The convergent and discriminant validity of the multiple-item scales were tested with confirmatory factor analysis (Long 1983).[2] Convergent validity, which is the degree with which the items of a given scale are measuring the same underlying latent variable, was assessed with three ad hoc tests recommended by Anderson and Gerbing (1988). Table 4 lists the standardized loadings, composite reliabilities, and variance-extracted estimates that were used in the ad hoc tests. First, standardized factor loadings, which are indicators of the degree of association between a scale item and a latent variable, are each highly significant, with t-values ranging from 7.53 to 20.82. Second, composite reliabilities, which are similar to Cronbach's alphas, range from 0.88 to 0.96, which exceed the customary lower limit of 0.70. Third, variance-extracted estimates, which are measures of the variation explained by the latent variable relative to random measurement error (Netemeyer et al. 1990), ranged from 0.52 to 0.85. These estimates exceed the 0.50 lower limit recommended by Fornell and Larker (1981). All tests support the convergent validity of the multiple-item scales.

Discriminant validity was assessed with two tests recommended by Anderson and Gerbing (1988). First, the squared correlation between a pair of latent variables (see Part B of Table 3) should be less than the variance-extracted estimate of each variable (see Table 4). The test was applied to every combination of latent variables. Each pairing passed the test. Second, confidence intervals constructed around the pairwise correlation between latent variables do not contain the value of 1.00. These results support the discriminant validity of the multiple-item scales.

Model Testing

The structural models are evaluated on the basis of five goodness-of-fit measures. A widely used fit measure is

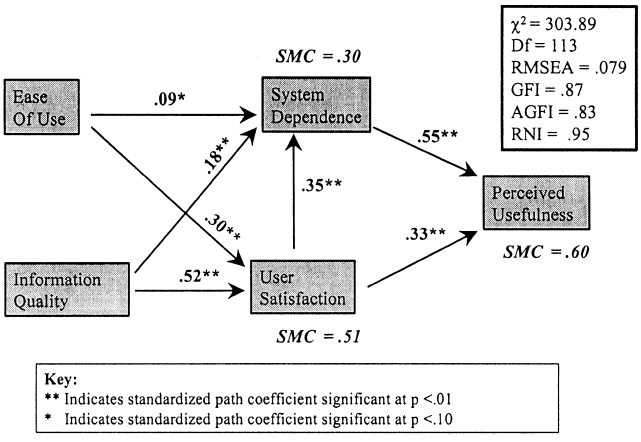
[2]A measurement model containing System Quality, Information Quality, and Perceived Usefulness had a chi-square fit estimate of 221.17 ($df = 87$, $p < 0.001$). The significance of the chi-square estimate indicates poor fit. However, the estimate should not be used as an absolute indicator of goodness of fit. Alternative fit indices indicate good fit. The root mean square residual (RMSEA) is 0.075, which is within the 0.08 threshold of good fit (e.g., Browne and Cudeck 1993). The goodness-of-fit index (GFI) is 0.90, and the relative noncentrality index is 0.96. These two measures exceed the customary 0.90 level for good fit (e.g., Bentler and Bonett 1980). The adjusted goodness-of-fit index (AGFI) is 0.86, which is just below the 0.90 threshold.

the statistical significance of the chi-square statistic, which indicates whether the model has a poor fit with the data. The drawback of the chi-square test is that significance is sensitive to sample size and the number of parameters in the model (Bentler and Bonett 1980), and as a consequence, the test may provide an inappropriate indication of poor fit. The fit of the models is evaluated in terms of four alternative measures that are less sensitive to sample size or model complexity. These are: (a) Steiger's (1990) root mean square error of approximation (RMSEA), which is recommended by Browne and Cudeck (1993), (b) the goodness-of-fit index (GFI), which outperformed other alternative indices in a study by Marsh et al. (1988), (c) the adjusted goodness-of-fit index (AGFI), which adjusts the GFI for degrees of freedom, and (d) the relative noncentrality index (RNI, McDonald and Marsh 1990), which Gerbing and Anderson (1993) identify as the best of the indices they studied.

The DeLone and McLean Model

The fit statistics and estimated path coefficients for the DeLone and McLean model are reported in Figure 3. The fit estimates provide mixed signals concerning the goodness of fit of the DeLone and McLean structural model. RNI is above the threshold of 0.90 recommended by Bentler and Bonett (1980) for good fit, and RMSEA is below the 0.10 level Browne and Cudeck (1993) set as a maximum allowable for an acceptable model. Thresholds for GFI and AGFI in IS research have been argued at above 0.90 and above 0.80, respectively (Segars and Grover 1993, Chin and Todd 1995), while a more restrictive 0.90 threshold for AGFI is also cited (Hair et al. 1995, Chin and Todd 1995). GFI is below the recommended 0.90 threshold for good fit, and the chi-square estimate was significant ($p < 0.001$), suggesting poor fit. The AGFI is above the 0.80 threshold, but does not meet the more restrictive 0.90 threshold level.

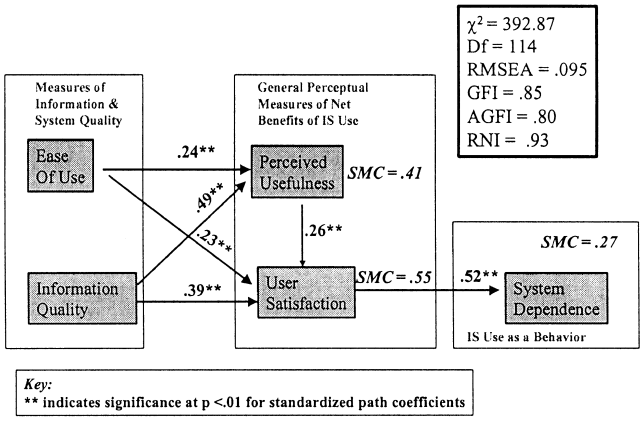
Figure 3 LISREL Results for DeLone and McLean Model



The Seddon Model

Fit statistics and estimates of path coefficients for the Seddon structural model are reported in Figure 4. As with the DeLone and McLean model, the fit estimates provide mixed signals concerning the goodness of fit of the Seddon structural model. In a comparative sense, the DeLone and McLean model has superior fit indices. For instance, RNI is 0.95 and RMSEA is 0.079 for the Delone and McLean structural model, while RNI is 0.93 and RMSEA is 0.095 for the Seddon structural model.[3]

Figure 4 LISREL Results for Seddon's Model



[3]A comparison of the chi-square fit of the modified Seddon structural model with the chi-square fit of the fully saturated model was conducted to investigate whether unspecified paths substantially increase model fit. The differences in chi-square fit are very small and nonsignificant, and below the threshold of 5.0 recommended by Marsh and Hocevar (1985) for substantial improvement in model fit. This indicates that the inclusion of additional paths would not substantially improve model fit. We conclude that the modified model adequately represents the structural characteristics of the data, and no other paths were investigated.

Modification of the Seddon Model

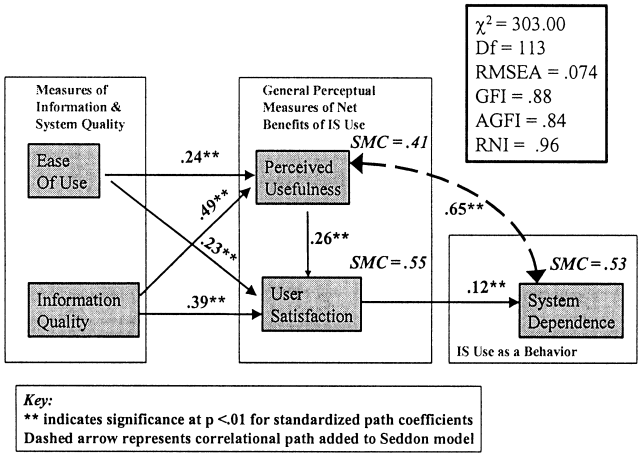
A noteworthy difference between the DeLone and McLean structural model and the Seddon structural model is that the DeLone and McLean structural model includes a path between IS Use and Perceived Usefulness, whereas the Seddon model does not. The omission of the path in the Seddon structural model may be contributing to its lower fit. LISREL computes a modification index for each direct path that is constrained to zero. The index values provide clues as to the constrained path that would contribute most to model fit if it had been freely estimated. For example, a modification index is computed for the paths from Perceived Usefulness, Information Quality, and System Quality to IS Use, paths that were not included in Seddon's model. The path from Perceived Usefulness to IS Use had the highest modification index, indicating that the addition of this path to the structural model would yield the greatest improvement in model fit. While the modification index provides indications of a relationship, the reconstruction of models on the basis of statistical results must be approached cautiously (MacCallum 1995). The significance of the path between two constructs may be a product of chance variation in the data rather than a reflection of an underlying structural relationship. Therefore, it is inappropriate to use significance alone to reconstruct the structural relationships of the model.

However, we contend that a structural path between Perceived Usefulness and IS Use in the Seddon model is tenable in our empirical context. Some employees interface with SIS to generate information essential for job performance while, for others, SIS information is incidental to their jobs. Perceived Usefulness, which relates to enhancing job performance (Davis 1989), may reflect the degree to which SIS information is essential for job performance. Due to various factors, such as no ready access to the information through other means, SIS may be the users' only viable choice for accessing job-related information. Without viable alternative systems, perceived usefulness of SIS may not be assessed relative to competing information systems, but more in terms of the need for the information that SIS provides. The more that SIS contains essential information for the job, the more users will access SIS for the needed information and, without a viable alternative to judge the worth of SIS, the more users will aggrandize the usefulness of SIS for the valuable information it provides. This reasoning suggests that Perceived Usefulness and IS Use, assessed in terms of dependence, may operate together because they are both related with the same extraneous variable, the degree to which SIS-stored information is essential for the job. Because of the presence of an extraneous variable, the structural path between Perceived Usefulness and IS Use may be correlational rather than causal, which would not invalidate Seddon's model.

Further, note that the Seddon's partial behavioral model of IS use has a path from Expectations of Net Benefits from Future Use to IS Use. We have not measured expectations of net benefits from future use, per se. However, our measure of Perceived Usefulness is an adaptation of Davis' future-tense-oriented perceived-usefulness items, which are designed to capture expected future benefits from use of an IS (Davis 1989). If future-tense Perceived Usefulness scores are similar to past-tense Perceived Usefulness scores collected in this study, the path from perceived usefulness to IS use is consistent with the Seddon model.

LISREL was applied to a modified structural representation of the Seddon model that included a correlational (nondirectional) relationship between Perceived Usefulness and IS Use. Path coefficients and fit indices for the modified structural model are presented in Figure 5. RMSEA improves from 0.095 to 0.074, and

Figure 5 LISREL Results for Amended Seddon's Model



RNI improves from 0.93 to 0.96. With the addition of the path from Perceived Usefulness to IS Use, the effect of User Satisfaction on IS Use drops substantially. Given the quasi-volitional nature of SIS use, SIS utilization is largely shaped by the effect of information quality on perceived usefulness and the effect of perceived usefulness on IS use.[4]

Table 5 summarizes the fit indices and squared multiple correlations associated with the three models. The DeLone and McLean model and the Amended Seddon model exhibit similar results, with both possessing better fit characteristics than the Seddon model. The Amended Seddon model, however, slightly outperforms the DeLone and McLean model in terms of fit. For example, the RMSEA is lower (0.074 versus 0.079), and the RNI and AGFI are each larger by 0.01. In addition, the amended Seddon model provides a substantially better explanation of System Dependence and a marginally better explanation of User Satisfaction than the DeLone and McLean model as exhibited by the SMCs. On the other hand, the DeLone and McLean model provides a substantially better explanation of Perceived Usefulness than the modified Seddon model. As the models differ in their positioning of these variables, we computed an average SMC measure. Here, too, the Amended Seddon model slightly outperforms the DeLone and McLean model, as the average SMC improves from 47% to 49.67%.

Table 5 Statistical Results for the Models

	Model		
Statistics	DeLone and McLean	Seddon	Amended Seddon
χ^2	303.89	392.87	303.00
Degrees of freedom	113	114	113
RMSEA	0.079	0.095	0.074
GFI	0.87	0.85	0.88
AGFI	0.83	0.80	0.84
RNI	0.95	0.93	0.96
SMC Perceived Usefulness	0.60	0.41	0.41
SMC for User Satisfaction (%)	51	55	55
SMC System Dependence (%)	30	27	53
Average SMC explained (%)	47	41	49.67

Discussion

Davis' Technology Acceptance Model (TAM), which is an adaptation of the Theory of Reasoned Action, and the Theory of Planned Behavior, are two of the most popular models used to explain IS behavior (Taylor and Todd 1995). These models have been rigorously tested in a variety of contexts. We use these models to interpret results and assess the theoretical validity of the relationships. This study specified and empirically assessed the DeLone and McLean (1992) and Seddon (1997) IS success models. Specifically, three structural models were examined: (a) a DeLone and McLean structural model, (b) a Seddon structural model, and (c) a Seddon structural model, modified to include a correlational path between Perceived Usefulness and IS Use. The ability of the structural models to fit data acceptably provides verification of DeLone and McLean's argument for an integrated model among their taxonomic categories and supports research application of integrated models of IS success (e.g., Hunton and Flowers 1997).

Classes of Variables

TAM suggests that two key beliefs, Perceived Usefulness and Perceived Ease of Use, shape users' behavioral intentions, which in turn impact IS Use. Perceived Ease of Use has a direct impact on Perceived Usefulness. IS Use is directly impacted by behavioral intention (BI). BI is a weighted function of attitude towards usage and Perceived Usefulness. Perceived Usefulness and Perceived Ease of Use determine attitudes toward usage. According to Davis, all other factors are expected to impact intentions and usage through ease of use and usefulness. Thus, TAM consists of three classes of variables: beliefs about the system, attitudes about using the system, and usage behavior.

TPB suggests that behavioral intention is formed by one's attitude towards performing a behavior. Attitudes, in turn, are formed by the aggregation of core beliefs about performing a behavior and the desirability of that behavior. In addition, TPB considers subjective norms and perceived behavioral control as impacting behavioral intention, and perceived behavioral control and behavioral intention as impacting usage behavior. As with TAM, TPB consists of three classes

of variables, namely beliefs about the system and environment, attitudes about using the system, and usage behaviors.

DeLone and McLean's model consists of six categories of variables: Information Quality, System Quality, IS Use, User Satisfaction, Individual Impacts, and Organizational Impacts. Seddon's model considers three classes of variables: measures of information and system quality, general measures of net benefits of IS use, and behavior with respect to IS use. Measures of information and system quality represent beliefs, general measures of net benefits of IS use represents attitudes, and behavior with respect to IS use focuses on behavioral measures. TAM, TPB, and the Seddon model treat variables at the higher level of beliefs, attitudes, and behavior to develop relationships and inform theory formulation.

Beliefs in IS Success Models

Both the DeLone and McLean (1992) and Seddon (1997) models focus on beliefs about System Quality, which includes Ease of Use as considered in TAM. In addition, these models consider Information Quality, a belief not explicitly considered in TAM. Perceived Usefulness, as an attitudinal measure of net benefits, is developed. Seddon's model elaborates the causal structure of TAM by separating beliefs about *expectations* of net benefits associated with using the system and general perceptual measures of net benefits associated with IS use. Perceived Usefulness, defined as an attitudinal measure of net *realized* benefits, is impacted by beliefs about information quality and system quality. By impacting attitudes about net realized benefits, information and system quality shape expectations of net benefits from future use, which equates to beliefs about Perceived Usefulness as considered in TAM. The DeLone and McLean model does not explicitly consider Perceived Usefulness. As discussed earlier, Perceived Usefulness, as an attitudinal measure of net realized benefits, is best placed in their Individual Impacts category of variables.

Perceived Usefulness in IS Success Models

Seddon's model specifies Perceived Usefulness as directly impacted by beliefs about System Quality and Information Quality. Our results suggest that the effect of Information Quality on Perceived Usefulness is substantially greater than the effect of Ease of Use on Perceived Usefulness. In the DeLone and McLean model, Perceived Usefulness is indirectly impacted by beliefs about Ease of Use and Information Quality through their effects on User Satisfaction and IS Use. Here too, the effects of Information Quality on System Dependence, the measure of IS Use considered here, and User Satisfaction, are greater than the effects of Ease of Use on these variables. Perceived Usefulness, as an attitudinal measure of net benefits, is impacted by Satisfaction and IS Use. Our results suggest that in contexts where effective task execution substantially depends on information delivered by the system, beliefs about Information Quality are more dominant in shaping IS Success than beliefs about Ease of Use.

User Satisfaction in IS Success Models

Both the Seddon (1997) and DeLone and McLean (1992) models specify User Satisfaction as impacted by beliefs about Ease of Use and Information Quality. These relationships are consistent with TAM and TPB, where attitudes about using the system are impacted by beliefs about the system. Given the positioning of Perceived Usefulness in the Individual Impact category of the DeLone and McLean model, Perceived Usefulness is caused by User Satisfaction and IS Use. On the other hand, in the Seddon model, User Satisfaction is impacted by Perceived Usefulness. To the degree that Perceived Usefulness, as an attitudinal measure of net realized benefits, is similar to the expectations of future benefits to be realized by using the system, Seddon's model parallels the specifications of TAM and TPB, where beliefs about Perceived Usefulness shape User Satisfaction, thereby influencing IS Use.

IS Use in IS Success Models

Our results support the posited impact of User Satisfaction on IS Use, assessed by System Dependence, as suggested by the DeLone and McLean (1992) and Seddon (1997) models. This relationship is consistent with TAM and TPB, as these models also specify attitudes towards using the system as shaping system usage behavior.

Perceived Usefulness, assessed in terms of net realized benefits, and IS Use, assessed in terms of dependence, may operate together, as they are both related with the same extraneous variable, the degree to which

SIS-stored information is critical for the job. The Theory of Planned Behavior suggests that considering beliefs about system compatibility, which includes task-technology compatibility, are important in assessing attitudes toward IS Use. Because of the presence of an extraneous variable, the structural path between Perceived Usefulness (assessed in terms of net realized perceptual benefits) and IS Use may be correlational rather than causal. A specification of such a path in Seddon's model produced the model with the best fit. A close look at the causal structure of Seddon's model supports specification of a correlational relationship between Perceived Usefulness and Satisfaction. Perceived Usefulness impacts satisfaction, which impacts expectations about future benefits, thereby impacting IS Use. IS Use and its associated consequences provide feedback to Perceived Usefulness, assessed as net benefits accrued.

With the addition of a nondirectional path between Perceived Usefulness and IS Use in the modified Seddon structural model, the effect size of User Satisfaction on IS Use was reduced, while a strong relationship between Dependence on IS and Perceived Usefulness was observed. SIS provides necessary information for job performance and using other means to obtain this information is laden with procedural complexities. If information is perceived as useful because it contains job-relevant information not easily available through other means, then the IS will be used irrespective of a person's overall satisfaction with the system.

Limitations

Seddon (1997) respecifies and expands DeLone and McLean (1992) by including individual, organizational, and societal consequences of IS use and other (e.g., nonperceptual) measures of net benefits. Because the questionnaire did not measure consequences of IS use, the value of these contributions could not be assessed with our data set. The fact that we did not examine all elements and relationships represented in the DeLone and McLean (1992) and Seddon (1997) models raises some concerns. Expanding investigations to span multiple individuals, systems, and organizations is a useful direction to further examine the validity of these models.

The use of questionnaires for the measurement of model variables may have introduced common-method variance and inflated the degree of variation between variables. In addition, the isolation on one IS severely limits generalization. A more rigorous approach for testing IS Success models is to establish either the organization or the IS as the experimental unit and assess variables, such as System Quality, Information Quality, and IS Use with more objective measures.

We assessed overall satisfaction with the system by using a one-item omnibus measure. Similarly, we used a one-item measure to assess system dependence. Multi-item measures can be used to capture aspects of these constructs conceivably not assessed here. Similarly, we limited our measurement of Individual Impact in the DeLone and McLean model to Perceived Usefulness, and our measurement of System Quality was limited to Ease of Use. Measurement of these constructs needs to be elaborated on to more effectively represent their entirety.

The data were collected by a questionnaire administered to users of the same IS. We did not assess the opinions of decision makers associated with the system. In our context, these individuals are the senior university administrators who are responsible for decisions on resources directed to enhance the system, provide training, or evaluate alternative systems. The beliefs, attitudes, and behaviors of users should play a major role in impacting these decision makers in their assessment of the system. The fact that 74% of our respondents were female raises questions about the gender representation in our sample vis-à-vis the computing population. This could conceivably have implications for the external validity of our results.

Concluding Remarks and Suggestions for Future Research

A primary contribution of our study is to have started a stream of work to empirically test the DeLone and McLean IS Success model (1992) and its proffered refinement by Seddon (1997). We specify the two models in a quasi-volitional usage context, operationalize key IS success constructs by using previously validated measures, and test the relationships between these measures, as purported by the two models. The empirical evidence suggests that both models have explanatory power, suggesting that each model has merit for explaining IS success. The study validates the importance of using an integrated, multiconstruct

dependent measure of IS success that considers beliefs, attitudes, and behaviors, as opposed to using a unidimensional success measure or one that does not consider interdependencies between elements of IS success. In contexts such as the present one, where effective task execution substantially depends on information delivered by the system, information quality is much more critical in shaping IS Success, including impacting user behavior, than beliefs about Ease of Use.

Future research should examine how IS success models perform in different contexts, including settings that range from strictly voluntary to strictly involuntary use, and recommend refinements as appropriate. Given the large number of studies focused on various aspects of IS Success, a meta-analysis to determine dominant findings, contrasted by key contextual variables, may be feasible.

Variables considered under each of the categories identified by DeLone and McLean (1992) and Seddon (1997) need to be carefully selected and defined for different contextual settings. In a recently edited book on *Information Systems Success Measurement* by Garrity and Sanders (1998), eight out of the nine chapters refer to, and build upon, the work of DeLone and McLean. Elaborations to the DeLone and McLean model suggested include consideration of service quality and cultural variables (Ishman 1998), distinctions between process and outcome satisfaction (Woodroof and Kasper 1998), and distinctions between task support satisfaction, quality of work-life satisfaction, interface satisfaction, and decision-making satisfaction (Garrity and Sanders 1998).

Another topic for future research is whether the concepts of Seddon's model require different definitions depending upon the context of the IS. In contexts of complete volitional use, users may interpret usefulness as the degree to which the characteristics of an IS (e.g., ease of use, accuracy, format) serve to enhance job performance (e.g., Seddon 1997, Table 1). On the other hand, where social norms or formal job requirements encourage or mandate system usage, users may interpret usefulness more narrowly as the degree to which the information supplied by the IS during job performance is important. In our present context, usefulness may be perceptually inflated due to the centrality of the accessed information to one's job. For the most part, centrality of information to a job is dictated by the job, not the IS. As a result, usefulness may be perceived independently from users' assessments of system quality characteristics.

Models of IS success need to be critically evaluated, refined, and tested in emergent IS use settings, such as e-commerce. There is anecdotal appreciation of the need for successful e-commerce systems to support increased reach or connectivity, range of applications, and richness of delivered information (Evans and Wurster 1999). What implications do the need for such capabilities have on the set of beliefs about e-commerce systems, which shape user's attitudes about net realized gains, thereby impacting user behavior? Indeed, it is not even clear the extent to which these models of IS success apply to e-commerce, given that these models are focused on internal users and not on an external constituency. They would seem to apply well to intranets, and with a sufficiently broad definition of e-commerce that included intranets, the use of the models in examining employee behaviors would seem to be appropriate.

Seddon's model provides a logical separation and linkage between IS success models, which focus on beliefs about system quality and information quality, and perceptions of net benefits from IS use, and a behavioral model of IS use. But what are the key elements of a behavioral model of IS use in e-commerce settings? Do these elements differ for business-to-business, business-to-consumer, and consumer-to-consumer e-commerce systems? Traditional IS systems were targeted at internal organization users at operational, tactical, and strategic levels. The focus of much of the past IS success research has been on explaining IS use in these settings, where IS use has been typically assessed by time spent using the system. Organizations are rapidly introducing Web-based systems to sell and distribute their products and services. These systems are targeted at consumers, who are entities external to the organization. Clearly, just having hits on a website in such situations does not achieve much more than a clogged site. Carefully calibrated measures of utilization seem appropriate, as building consumer dependence on a site may be a way to cultivate loyalty and achieve retention. On the other hand, horizontal por-

tals such as Yahoo!, with their business models dependent on advertising revenue, are effective if they achieve high "eyeball hit rates." Assuming the traditional IS success models are applicable to e-commerce, such systems would shift the behavioral focus from internal organizational use of a system to metrics that assess current and recurring patterns of interaction with consumers and suppliers. The properties of the business model would appear to be an important consideration in defining the pattern of interaction between the system and external entities in this case. Future IS research could conceivably make a valuable contribution to the design and measurement of e-commerce systems by specifying and testing traditional IS Success models in these emergent contexts. On the other hand, researchers may devise new constructs and linkages that are specific to the e-Commerce context, and, in this case, the IS field needs to be made aware of the possibility of IS success models that differentiate.

Acknowledgments

The authors would like to thank the Senior Editor, Associate Editor, and four anonymous reviews for their comments, which substantially improved the quality of this paper.

Appendix 1. Correlation Matrix of Measurement Items

Items	IQ1	IQ2	IQ3	IQ4	IQ5	IQ6	IQ7	EOU1	EOU2	PU1	PU2	PU3	PU4	PU5	PU6	Satisfaction	Utilization
IQ1	1																
IQ2	0.82	1															
IQ3	0.77	0.74	1														
IQ4	0.39	0.42	0.39	1													
IQ5	0.55	0.55	0.58	0.46	1												
IQ6	0.33	0.41	0.33	0.26	0.31	1											
IQ7	0.54	0.56	0.56	0.40	0.57	0.48	1										
EOU1	0.33	0.38	0.32	0.31	0.34	0.42	0.41	1									
EOU2	0.36	0.39	0.37	0.34	0.32	0.38	0.42	0.85	1								
PU1	0.41	0.44	0.44	0.29	0.40	0.23	0.38	0.34	0.34	1							
PU2	0.46	0.48	0.44	0.30	0.44	0.26	0.47	0.39	0.41	0.72	1						
PU3	0.45	0.49	0.45	0.24	0.41	0.29	0.42	0.41	0.43	0.76	0.84	1					
PU4	0.46	0.49	0.48	0.27	0.45	0.28	0.45	0.40	0.40	0.73	0.86	0.90	1				
PU5	0.47	0.47	0.49	0.28	0.42	0.24	0.40	0.40	0.41	0.74	0.75	0.82	0.82	1			
PU6	0.46	0.46	0.48	0.24	0.43	0.27	0.46	0.37	0.40	0.72	0.75	0.81	0.82	0.83	1		
Satisfaction	0.57	0.54	0.53	0.41	0.57	0.34	0.54	0.51	0.51	0.50	0.58	0.53	0.57	0.56	0.58	1	
Utilization	0.40	0.36	0.43	0.15	0.36	0.18	0.35	0.33	0.35	0.60	0.61	0.68	0.65	0.67	0.69	0.52	1

Appendix 2. Covariance Matrix of Measurement Items

Items	IQ1	IQ2	IQ3	IQ4	IQ5	IQ6	IQ7	EOU1	EOU2	PU1	PU2	PU3	PU4	PU5	PU6	Satisfaction	Utilization
IQ1	0.82																
IQ2	0.70	0.89															
IQ3	0.61	0.61	0.76														
IQ4	0.27	0.31	0.26	0.59													
IQ5	0.39	0.40	0.40	0.28	0.63												
IQ6	0.34	0.43	0.32	0.23	0.26	1.27											
IQ7	0.43	0.46	0.43	0.27	0.39	0.48	0.78										
EOU1	0.36	0.42	0.33	0.28	0.32	0.56	0.42	1.38									
EOU2	0.37	0.42	0.37	0.29	0.29	0.48	0.42	1.12	1.27								
PU1	0.34	0.37	0.34	0.20	0.28	0.23	0.30	0.36	0.34	0.81							
PU2	0.44	0.47	0.40	0.24	0.36	0.30	0.43	0.48	0.48	0.67	1.08						
PU3	0.43	0.48	0.41	0.20	0.34	0.34	0.39	0.51	0.51	0.72	0.93	1.12					
PU4	0.42	0.46	0.42	0.21	0.36	0.31	0.40	0.47	0.45	0.66	0.89	0.95	1.01				
PU5	0.47	0.48	0.47	0.23	0.36	0.29	0.38	0.51	0.50	0.72	0.85	0.94	0.90	1.18			
PU6	0.39	0.41	0.40	0.17	0.32	0.29	0.38	0.41	0.43	0.61	0.73	0.80	0.78	0.84	0.88		
Satisfaction	0.37	0.36	0.32	0.22	0.32	0.27	0.33	0.42	0.40	0.32	0.43	0.40	0.40	0.43	0.38	0.50	
Utilization	0.55	0.52	0.58	0.18	0.44	0.31	0.48	0.59	0.61	0.82	0.97	1.11	0.99	1.11	1.00	0.56	2.35

References

Adams, D. A., R. R. Nelson, P. A. Todd. 1992. Perceived usefulness, ease of use, and usage of information technology: A replication. *MIS Quart.* **16** 227–247.

Anderson, J. C., D. W. Gerbing. 1988. Structural equation modeling in practice: A review and recommended two-step approach. *Psych. Bull.* **103**(May) 411–423.

Armstrong, J., T. Overton. 1977. Estimating nonresponse bias in mail surveys. *J. Marketing Res.* **14** 396–402.

Bailey, J. E., S. W. Pearson. 1983. Development of a tool for measuring and analyzing computer user satisfaction. *Management Sci.* **29**(May) 530–545.

Bailey, K. D. 1978. *Methods of Social Sciences Research.* The Free Press, New York.

Ballantine, J., M. Bonner, M. Levy, A. Martin, I. Munro, P. L. Powell. 1996. The 3-D model of information systems success: The search for the dependent variable continues. *Inform. Resources Management J.* **9**(4) 5–14.

Baroudi, J. J., W. J. Orlikowski. 1988. A short-form measure of user information satisfaction: A psychometric evaluation and notes on use. *J. Management Inform. Systems* **4**(Spring) 44–59.

Bentler, P. M., D. G. Bonett. 1980. Significance tests and goodness-of-fit in the analysis of covariance structures. *Psych. Bull.* (November) 588–606.

Boudreau, M., D. Gefen, D. W. Straub. 2001. Validation in IS research: A state-of-the-art assessment. *MIS Quart.* **25**(1) 1–24.

Browne, M. W., R. Cudeck. 1993. Alternative ways of assessing model fit. K. A. Bollen and J. S. Long, eds. *Testing Structural Equation Models.* Sage Publications, Newbury Park, CA 136–162.

Chin, W. W., P. A. Todd. 1995. On the use, usefulness, and ease of use of structural equation modeling in MIS research: A note of caution. *MIS Quart.* **19**(June) 237–246.

Chou, C. P., P. M. Bentler. 1996. Estimates and tests in structural equation modeling. R. H. Hoyle, ed. *Structural Equation Modeling.* Sage Publications, Thousand Oaks, CA 37–55.

Davis, F. D. 1989. Perceived usefulness, perceived ease of use, and user acceptance of information technology. *MIS Quart.* **13**(September) 318–340.

——, R. P. Bagozi, P. R. Warshaw. 1989. User acceptance of computer technology: A comparison of two theoretical models. *Management Sci.* **35** (August) 982–1003.

DeLone, W. H., E. R. McLean. 1992. Information systems success: The quest for the dependent variable. *Inform. Systems Res.* **3**(1) 60–95.

Doll, W. J., G. Torkzadeh. 1988. The measurement of end-user computing satisfaction. *MIS Quart.* **12**(June) 259–273.

——, W. Xia, G. Torkzadeh. 1994. A confirmatory factor analysis of the end-user computing satisfaction instrument. *MIS Quart.* **18**(4) 453–461.

Evans, P., T. Wurster. 1999. *Blown to Bits.* Harvard Business School Press, Cambridge, MA.

Fornell, C., D. F. Larcker. 1981. Evaluating structural equation models with observable variables and measurement error. *J. Marketing Res.* **18**(February) 39–50.

Garrity, E. J., G. L. Sanders. 1998a. *Information Systems Success Measurement.* Idea Group Publishing, Harrisburg, PA.

——,——. 1998b. Dimensions of information systems success. E. J. Gurnity and G. L. Sanders, eds. *Information Systems Success Measurement.* Idea Group Publishing, Harrisburg, PA.

Gerbing, D. W., J. C. Anderson. 1993. Monte Carlo evaluations in goodness-of-fit indices for structural equation models. K. A. Bollen and J. S. Long, eds. *Testing Structural Equation Models.* Sage Publications, Newbury Park, CA 40–65.

Goodhue, D. L. 1995. Understanding user evaluations of information systems. *Management Sci.* **41**(December) 1827–1844.

——, R. L. Thompson. 1995. Task-technology fit and individual performance. *MIS Quart.* **19**(June) 213–236.

Hair, J. F., Jr., R. E. Anderson, R. L. Tatham, W. C. Black. 1995. *Multivariate Data Analysis with Readings.* Prentice Hall, Englewood Cliffs, NJ.

Hartwick, J., H. Barki. 1994. Explaining the role of user participation in information system use. *Management Sci.* **40**(April) 440–465.

Hendrickson, A. R., K. Glorfeld, T. P. Cronan. 1994. On the repeated test-retest reliability of the end-user computing satisfaction instrument: A comment. *Decision Sci.* **25**(4) 655–667.

——, P. D. Massey, T. P. Cronan. 1993. On the test-retest reliability of perceived usefulness and perceived ease of use scales. *MIS Quart.* **17**(June) 247–230.

Hunton, J. E., L. Flowers. 1997. Information technology in accounting: Assessing the impact on accountants and organizations. S. C. Sutton, ed. *Advances in Accounting Information Systems.* JAI Press, Greenwich, CT 3–34.

Igbaria, M., T. Guimaraes, G. B. Davis. 1995. Testing the determinants of microcomputer usage via a structural equation model. *J. Management Inform. Systems* **11**(Spring) 87–114.

Ishman, M. 1998. Measuring information success at the individual level in cross-cultural environments. E. J. Garrity and G. L. Sanders, eds. *Information Systems Success Measurement.* Idea Group Publishing, Harrisburg, PA.

Joreskog, K. G., D. Sorbom. 1993. *LISREL VIII User's Reference Guide.* Lawrence Erlbaum, Hillsdale, NJ.

Kim, K. K. 1989. User satisfaction: A synthesis of three different perspectives. *J. Inform. Systems* **3**(Fall) 1–12.

Long, J. S. 1983. *Confirmatory Factor Analysis.* Sage Publications, Newbury Park, CA.

MacCallum, R. C. 1995. Model specification: Procedures, strategies, and related issues. R. H. Hoyle, ed. *Structural Equation Modeling.* Sage Publications, Thousand Oaks, CA. 16–36.

Magal, S. R. 1991. A model for evaluating information center success. *J. Management Inform. Systems* **8**(Summer) 91–106.

Marsh, H. W., and D. Hocevar. 1985. Applications of confirmatory factor analysis to the study of self-concept: First- and higher-order factor models and their invariance across groups. *Psych. Bull.* **100**(May) 562–582.

——, J. R. Balla, R. P. McDonald. 1988. Goodness-of-fit-indexes in confirmatory factor analysis: The effect of sample size. *Psych. Bull.* **103**(March) 391–411.

Mason, R. O. 1978. Measuring information output: A communications systems approach. *Inform. Management* **1**(5) 219–234.

McDonald, R. P., H. W. Marsh. 1990. Choosing a multivariate model: Noncentrality and goodness of fit. *Psych. Bull.* **107**(March) 247–255.

Moore, G. C., I. Benbasat. 1996. Integrating diffusion of innovations and theory of reasoned action models to predict utilization of information technology by end-users. K. Kautz and J. Pries-Heje, eds. *Diffusion and Adoption of Information Technology.* Chapman and Hall Publishers, London, U.K. 132–146.

Myers, B. L., L. A. Kappelman, V. R. Prybutok. 1997. A comprehensive model for assessing the quality and productivity of the information systems function: Toward a theory for information systems assessment. *Inform. Resources Management J.* **10**(1) 6–25.

Netemeyer, R. G., M. W. Johnston, S. Burton. 1990. Analysis of role conflict and role ambiguity in a structural equations framework. *J. Appl. Psych.* **75**(April) 148–157.

Nunnally, J. C. 1967. *Psychometric Theory.* McGraw-Hill, New York.

Rainer, Jr., R. K., H. J. Watson. 1995. The keys to executive information system success. *J. Management Inform. Systems* **12**(Fall) 83–98.

Seddon, P. B. 1997. A respecification and extension of the DeLone and McLean model of IS success. *Inform. Systems Res.* **8**(September) 240–253.

——, M. Y. Kiew. 1994. A partial test and development of DeLone and McLean's model of IS success. *Proc. Internat. Conf. Inform. Systems.* Vancouver, Canada 99–110.

——, S. K. Yip. 1992. An empirical evaluation of user information satisfaction (UIS) measures for use with general ledger accounting software. *J. Inform Systems* **6**(Spring) 75–92.

Segars, A. H., V. Grover. 1993. Re-examining perceived ease of use and usefulness: A confirmatory factor analysis. *MIS Quart.* **17**(December) 517–522.

Shannon, C. E., W. Weaver. 1949. *The Mathematical Theory of Communication.* University of Illinois Press, Urbana, IL.

Steiger, J. H. 1990. Structural model evaluation and modification: An interval estimation approach. *Multivariate Behavioral Res.* **25**(April) 173–180.

Straub, D. W. 1989. Validating instruments in MIS research. *MIS Quart.* **13**(2) 147–169.

——, L. Moez, E. Karahanna. 1995. Measuring system usage: Implications for IS theory testing. *Management Sci.* **41**(8) 1328–1342.

Taylor, S., P. A. Todd. 1995. Understanding information technology usage: A test of competing models. *Inform. Systems Res.* (June) 144–176.

Thompson, R. L., C. A. Higgins, J. M. Howell. 1994. Influence of experience on personal computer utilization: Testing a conceptual model. *J. Management Inform. Systems* **10**(Summer) 167–187.

Torkzadeh, G., W. J. Doll. 1991. Test-retest reliability of the end-user computing satisfaction instrument. *Decision Sci.* **22**(1) 26–37.

West, S. G., J. F. Finch, P. J. Curran. 1995. Structural equation models with nonnormal variables: Problems and remedies. R. H. Hoyle, ed. *Structural Equation Modeling.* Sage Publications, Thousand Oaks, CA 56–75.

Woodroof, J., G. M. Kasper. 1998. A conceptual development of process and outcome user satisfaction. E. J. Garrity and G. L. Sanders, eds. *Information Systems Success Measurement.* Idea Group Publishing, Harrisburg, PA.

Izak Benbasat, Senior Editor. This paper was received on January 4, 2000, and was with the authors 13 months for 4 revisions.