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A Partial Test and Development of the DeLone and McLean Model of IS Success

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ABSTRACT

DeLone and McLean's (1992) comprehensive review of different information system success measures concludes with a model of interrelationships between six IS Success constructs. This paper critically examines the meaning of four of these constructs and the evidence of relationships between them. It then provides results from an empirical test of these relationships.

The empirical results provide substantial support for DeLone and McLean's model. Three factors, System Quality, Information Quality, and Usefulness, are found to explain 72% of the variance in the overall User Satisfaction measure. Three factors, System Quality, Information Quality, and a measure of the importance of the system to the user, User Involvement, are found to explain 56% of the variance in Usefulness. The paper concludes that of the four measures studied, the best "omnibus" measure of IS success is User Satisfaction. This can be measured using the simple four-question instrument presented in the study.

1. INTRODUCTION

DeLone and McLean's (1992) comprehensive review of different information system success measures makes two important contributions to our understanding of Information System (IS) success. First, it provides a scheme for classifying the multitude of IS success measures that have been used in the literature into six categories. Second, it suggests a model of interdependencies between these categories. Commenting on their Figure 2, reproduced here as Figure 1a, DeLone and McLean say (p. 88):

> The I/S success model proposed in Figure 2 is an attempt to reflect the interdependent, process nature of I/S success. Rather than six independent success categories, there are six *inter*dependent dimensions to I/S success. This success model clearly needs further development and validation before it could serve as a basis for the selection of appropriate I/S measures.

The last sentence in the above quotation provides the motivation for this paper. We do not address the two right-hand constructs,[1] but we do examine the meaning of, and relationships between, the other four.

If the six categories of IS success measure in Figure 1a are treated as variables, the causal model implied by DeLone and McLean is as shown in Figure 1b. Each line in Figure 1b is, in effect, a hypothesis about an independent causal relationship between the constructs in the model. Thus the dotted-line box in Figure 1b contains six hypotheses (six arrows on the path diagram) linking the four success measures *System Quality*, *Information Quality*, *Use*, and *User Satisfaction*. This paper provides an empirical test of relationships between these four variables in the context of one specific information system. For reasons given below, the model actually tested is as shown in Figure 2. The three differences between the DeLone and McLean model (Figure 1b) and the model tested (Figure 2) are as follow:

(a) *Use* in the DeLone and McLean model has been replaced by *Usefulness*;

(b) a new variable, *User Involvement*, has been added to the DeLone and McLean model to help explain variations in users' perceptions of *Usefulness* and *User Satisfaction*[2];

(c) the simultaneous causality between *Use* and *User Satisfaction* in the DeLone and McLean model has been replaced by one-way causality, i.e., we argue that *Usefulness* causes *User Satisfaction*, not vice versa.

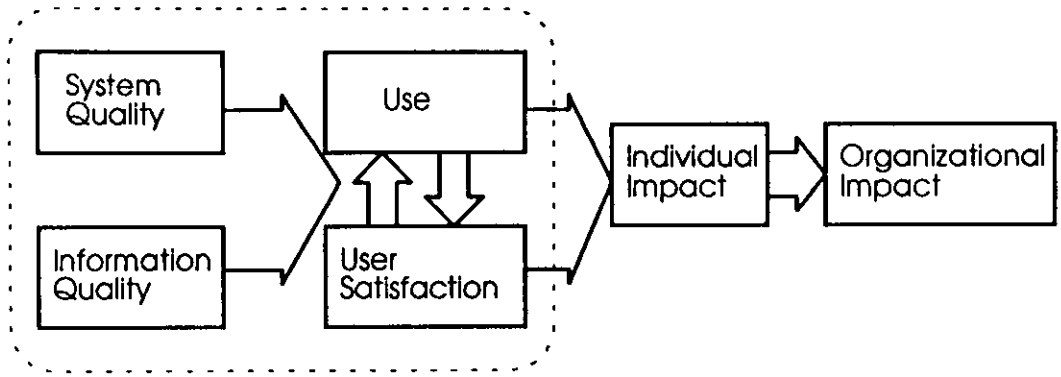

Figure 1a. The DeLone and McLean Model of IS Success
(DeLone and McLean 1992, Figure 2, p. 97;
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Providence, Rhode Island 02903 USA)

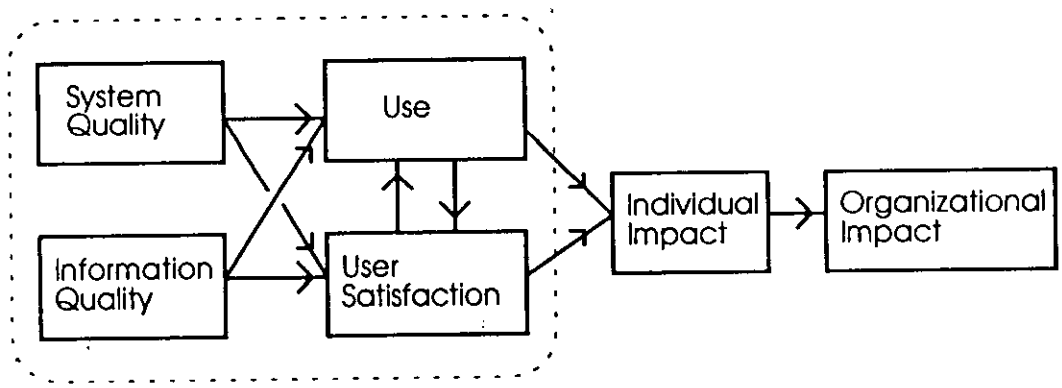

Figure 1b. Path Model Implied by the DeLone and McLean Model

The meaning of the four constructs used in Figure 2, and the theory supporting the relationships between them, are discussed in section 2. To test the model, data were collected from 104 users of a university's departmental accounting system. Discussion of methodology used for testing the model, measurement of variables, and test results are presented in section 3. Finally, in section 4, the paper concludes with a discussion of the implications of these results for the measurement of IS success. Our recommendation is that, of the four measures examined, *User Satisfaction* is the most general perceptual measure of information system success.

2. DEFINING CONSTRUCTS AND THEORIZING ABOUT THEIR RELATIONSHIPS

2.1 Replacing *Use* in Figure 1 by *Usefulness* in Figure 2

As reported by DeLone and McLean (1992), many researchers have used *Use* as an objective measure of system success. The implication is that, if a system is used, it must be useful and therefore successful. However, non-use does not necessarily mean a system is not useful; it may simply mean that there are other more pressing things to be

done. In addition, as DeLone and McLean point out, "usage, either perceived or actual, is only pertinent when such use is voluntary" (p. 68). When usage is compulsory, the number of hours a system is used conveys little information about system usefulness, and so success.

Reflecting on the relevance of *Use* as an indicator of system success in some situations and its irrelevance in others, we conjectured that the underlying success construct that researchers have been trying to tap is *Usefulness*, not *Use*. *Use* is a good proxy for *Usefulness* in situations where a tool is used and use is not mandatory. It then provides a simple objective measure of success. However, in cases where a system is not used during the period of study, or where usage is mandatory (as in the accounting system examined in this study), we argue that *Usefulness* continues to be a meaningful measure of success, even though *Use* does not. We therefore decided to measure *Usefulness*, not *Use*, in our test of the DeLone and McLean model (Figure 2).

2.2 The First Four Hypotheses in Figure 2 (H1—4)

The first four hypotheses to be tested in this paper follow directly from the DeLone and McLean model. The four, independent, hypotheses are

H1: Increases in *Information Quality* will cause increases in *User Satisfaction*
H2: Increases in *System Quality* will cause increases in *User Satisfaction*
H3: Increases in *System Quality* will cause increases in *Usefulness*
H4: Increases in *Information Quality* will cause increases in *Usefulness*

There are four constructs involved. *Information Quality* is concerned with such issues as the timeliness, accuracy, relevance, and format of information generated by an information system. *System Quality* is concerned with whether or not there are "bugs" in the system, the consistency of the user interface, ease of use, response rates in interactive systems, documentation, and, sometimes, quality and maintainability of the program code. *Usefulness* of an IS is "the degree to which a person believes that using a particular system would enhance his or her job performance" (Davis 1989). *Satisfaction* is "the result of the individual taking outcomes that have been received and evaluating them on a pleasant-unpleasant continuum" (Naylor, Prichard and Ilgen 1980).

There is quite strong support in the literature, both theoretical and empirical, for hypotheses H1 through H4. A brief summary of seven relevant studies follows.

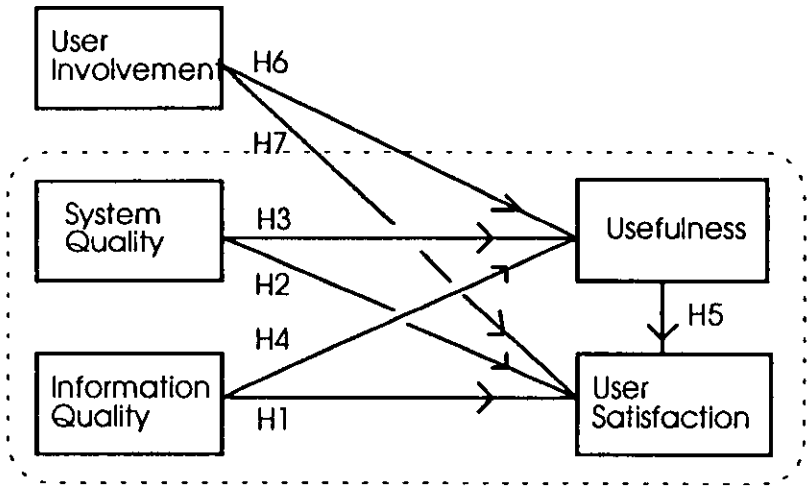

Figure 2. The Model of User Satisfaction Tested in this Study
(This figure is a slightly modified version of the variables within the dotted boxes in Figure 1b. *User Involvement* is as defined by Barki and Hartwick [1989].)

First, based on the work of Bailey and Pearson (1983), Ives, Olson, and Baroudi (1983) discuss the development of two instruments for measuring *User Satisfaction*. The longer of these instruments was factor analyzed into five factors: *EDP Staff and Services, Information Product 1, Vendor Support, Information Product 2,* and *Knowledge or Participation.*[3] The shorter instrument — later validated by Baroudi and Orlikowski (1988) — factor analyzed into three factors: *EDP Staff and Services, Information Product,* and *User Knowledge or Participation*. A number of researchers have been critical of the use of these multi-factor measures of user satisfaction. Treacy (1985) described the factors as "imprecise and ambiguous." Galletta and Lederer (1989) argued that because of the heterogeneity of the items, results from the Ives, Olson and Baroudi (1983) instruments should be "interpreted with caution". Our explanation of the factors that emerge from the Ives, Olson and Baroudi instruments is that they measure the independent variables that Bailey and Pearson and Ives, Olson and Baroudi thought were likely to *cause* Satisfaction, not *User Satisfaction* itself. In particular, we view the presence of so many questions about information quality in the Ives, Olson and Baroudi. User Satisfaction instruments as providing *theoretical* support for hypothesis 1 in Figure 2.

Second, in a recent empirical study, Seddon and Yip (1992) constructed a four-item instrument that attempts to measure *User Satisfaction* directly.[4] They compared this with the factors from the Ives, Olson and Baroudi Short Form instrument. Seddon and Yip found that, for users of computer-based accounting systems, factors such *Information Quality, Usefulness,* and *User Knowledge* of various system features explained over 70% of the variance in their *User Satisfaction* measure.[5] The t-statistics in their regression 7.3 (p. 89) indicate that *Information Quality* (t-statistic = 7.48) is an important determinant of *Satisfaction.* This provides strong *empirical* support for hypothesis 1 in Figure 2.

Third, Doll and Torkzadeh (1988) developed a measure of End User Computing Satisfaction (EUCS) that asked ten questions about *Information Quality* and two about *Ease of Use*. These questions factor analyzed into five factors. The first four factors relate to the construct that we call *Information Quality*: Information Content, Accuracy, Format, and Timeliness. The fifth factor is *Ease of Use,* a component of *System Quality.* As with the Ives, Olson and Baroudi instruments, we contend that Doll and Torkzadeh's instrument is actually measuring two variables that are *causes* of *User Satisfaction.* Thus as with the Ives, Olson and Baroudi. instrument, we view Doll and Torkzadeh's decision to include questions concerning *Information Quality* and *System Quality* in their measure of End User Computing Satisfaction as providing *theoretical* support for hypotheses 1 and 2 in Figure 2.

Fourth, in their empirical study, Seddon and Yip report that Doll and Torkzadeh's EUCS explained over 70% of the variance in their four-item *User Satisfaction* measure, but that after *Information Quality* was included in the regression, *Ease of Use* was not significant (regression 7.2). This provides further *empirical* support for hypothesis 1, but not for hypothesis 2.

Fifth, Davis has provided IS researchers with two highly reliable measures of *Perceived Usefulness* and *Ease of Use.* Davis was interested in explaining peoples' ex ante decisions to use information technology, but the measures seem equally applicable to ex post evaluations of information systems. Concerning *Ease of Use* (an important component of *System Quality*), Davis found significant correlations ($p < 0.001$) between *Ease of Use* and *Usefulness* for three of four systems studied (Table 8, p. 332) and suggests that "ease of use influences usage indirectly through its effect on usefulness" (p. 330). Davis's work provides both *theoretical* and *empirical* support for hypothesis 3 in Figure 2 (that increased *System Quality* is associated with increased *Usefulness*).

Sixth, in support of hypothesis 4, Larker and Lessig (1980, p. 123), Franz and Robey (1986), and Kraemer et al. (1993, Q.2a, p. 133) have all argued that increased *Information Quality* will lead to increased *Usefulness.* Franz and Robey include two questions in their *Perceived Usefulness* instrument (p. 353) that suggest they think higher *Information Quality* implies higher *Usefulness.* The first question asks: "To what extent does this system *overload* you with more data than it seems you can possibly use?" The second asks: "To what extent does this system provide report(s) to you that seem to be just about *exactly* what you *need*?" The comments from Larker and Lessig and Kraemer et al., and the inclusion of the two questions just cited in Franz and Robey's questionnaire all provide *theoretical* support for hypothesis 4 in Figure 2.

Seventh, Kraemer et al. studied factors that influence the perceived usefulness of computer-based information (CBI). They used regression analysis to assess the relative importance of factors that affect usefulness. For data from 211 operations managers in public organizations, they report: "Finally, from the foregoing factors, CBI accessibility, CBI quality, and reliance on experts were found to have the most significant influence on the perceived usefulness of CBI" (p. 139). This provides limited *empirical* support for hypothesis 4.[6]

2.3 *Usefulness* Causes *User Satisfaction*, Not Vice Versa (H5)

The DeLone and McLean model (Figure 1a) suggests that there is a two-way causal relationship between *Use* and *Satisfaction*. A simple duplication of this two-way relationship in Figure 2 would imply a two-way causal relationship between *Usefulness* and *Satisfaction*. Is this valid, or does the change from the *Use* construct to *Usefulness* introduce a subtle change in the causality relationships? As we could think of no statistical test to determine whether *Usefulness* causes *Satisfaction*, or vice versa, we were forced to resort to semantics to try to answer this question. The conclusions from of this back-to-first-principles analysis are presented in the next two paragraphs.

Something is *useful* if it provides future benefits.[7] A car is useful for getting to work. A bicycle is less useful for the same task because it goes slower and you may get wet if it rains. A car that won't start is not useful for getting to work today, but it will be useful again in the future once someone has got it working. A bicycle is not useful for getting to work today if you don't know how to ride. Consistently, across many examples, we found that *Usefulness* is concerned only with the future benefits of performing some task. Costs are much less important. For instance, your new $30,000 automobile may be judged to be marginally more useful than the reliable old $6,000 automobile it replaced, but not by five times. The benchmark for judging usefulness of a tool is that the value of the benefits flowing from its use in some specific task must exceed zero.

The benchmark for judging *satisfaction* is different. *User Satisfaction* is the net feeling of pleasure or displeasure that results from aggregating all the benefits that a person hopes to receive from interaction with the information system. Each user has a set of expected benefits or aspirations for the information system. To the extent that the system meets or fails to meet each of these aspirations, the user is more or less satisfied. At a minimum, a tool is expected to be useful. Beyond that, the more useful the tool, the more likely the user is to be satisfied with it. However, satisfaction reflects a wider set of expected benefits or aspirations than mere usefulness. For instance, we are more likely to be satisfied with our new $30,000 automobile than with the old $6,000 one, even though the annual cost of ownership is much higher. Assuming the new car is only marginally more useful than the old, this example implies that we must be valuing other non-usefulness benefits (such as comfort and status) in determining satisfaction.

Considerations along these lines lead us to believe that increases or decreases in *Usefulness* will lead to increases or decreases in *User Satisfaction* with information systems, but not vice versa (because some increases in *Satisfaction* are unrelated to *Usefulness*). This is the basis for hypothesis 5 in Figure 2:

H5: Increases in *Usefulness* will cause increases in *User Satisfaction*

In effect, we regard the DeLone and McLean model as saying that *User Satisfaction* responds primarily to three types of aspirations that people have for information systems: people want their information systems to be of high quality (H2), to provide high quality information (H4), and to be useful in their jobs (H5).

What support is there in the literature for the hypothesis that *Usefulness* causes *Satisfaction*, but not vice versa? While many researchers have studied the relationship between *Use* (a behavior) and *Satisfaction* (an attitude), the DeLone and McLean model is concerned with *Use* as a measure of success, i.e., with *Usefulness* (a belief).[8] Surprisingly few researchers have considered the relationship between *Usefulness* and *Satisfaction*. Apart from Bailey and Pearson, who used a question about *Utility* (the relative balance between cost and usefulness) in their measure of *Satisfaction*, and Goodhue (1986), who speculated that there might be weak links in both directions between *Satisfaction* and *Usefulness*, the most helpful study we could find was by Franz and Robey. Franz and Robey used *Perceived Usefulness* as the dependent variable in their study of user participation and organizational context. In discussing the choice of independent variable, they say "Our questions were designed to assess perceptions of usefulness rather than more-general attitudes...or satisfaction..." (p. 338).

It is clear from this sentence that they believe that *Satisfaction* is a more general concept than *Usefulness*. However, it is not clear how they think the two concepts are related. Since the Franz and Robey study was the only study we could find that offered clear insights to the relationship between *Usefulness* and *User Satisfaction*, we were forced to rely on the "first-principles" analysis above to justify our interpretation of the arrows in the DeLone and McLean model, i.e., to justify hypothesis 5.

2.4 *User Involvement* Used to Explain Variance in *Usefulness* and *User Satisfaction* (H6 and H7)

Because the DeLone and McLean model was proposed as a way of interrelating various measures of IS success, it does not consider factors that might influence peoples' evaluations of success. However, as all four constructs in the

dotted line box in Figure 2 are perceptual, it seems highly likely that users' opinions about the relevance of the system to their own goals and aspirations will influence their opinions about the success of the system. For example, if what the system does is unimportant to the user, there seems little chance that the user will perceive the system as useful, no matter how well designed it is or how easy it is to use. Conversely, if the task the system supports is perceived as very important, a poor system may be perceived as useful, even if it is quite user unfriendly. In this study of success measures, it therefore seems essential to consider the individual interests of the people being asked to evaluate the information system.

How should users' interests be incorporated into Figure 1b? For help in this regard, we turned to Barki and Hartwick's notion of *User Involvement*. Barki and Hartwick's (1989) somewhat revolutionary paper presents a strong case for distinguishing between *User Participation*, which they define as "participation in the system development process" (p. 53), and *User Involvement*, which they define as "the subjective psychological state" of the user "when he or she considers a system to be both important and personally relevant" (p. 53). This *User Involvement* concept is very similar to the task-relevance concept we had in mind, so we adopted it for our study. Intuitively, we felt that higher levels of *User Involvement* were likely to lead to higher perceptions of *Usefulness*. Thus H6 proposes that the greater the user's *Involvement* with an information system, the more *useful* it will be perceived to be. Additional support for H6 comes from Larker and Lessig (1980, p. 123). Larker and Lessig used the term "Perceived Importance" to refer to "the quality that causes a particular information set to acquire relevance to a decision maker," i.e., a concept similar to *User Involvement*. Consistent with our H6, they go on to argue that Perceived Importance will "tend to increase the perceived usefulness of the set."

The link from *User Involvement* to *Satisfaction* is less clear. Provided the system works, the more important the task to the user, the more satisfied he or she is likely to be (*Involvement* up, *Satisfaction* up). On the other hand, if the system does not work and the task is important, the user may be very dissatisfied (*Involvement* up, *Satisfaction* down). Finally, if the task is unimportant, the user's threshold for satisfaction may be so low (i.e., the user would be indifferent to the system) that satisfaction scores might be moderate (*Involvement* down, *Satisfaction* indeterminate). These last two scenarios would reduce correlations between *User Involvement* and *User Satisfaction*. On balance, since the system we proposed to test did work (though not very well), we expected the correlation to be positive. This is the basis for H7 in this study.

Perceptions of *System Quality* and *Information Quality* are less likely to be colored by individual goals and aspirations than perceptions of *Usefulness* and *Satisfaction*. For instance, twenty years ago, card-punch machines were the normal everyday way of communicating with computers. They were easy to use and they were useful. Today, they are no less easy to use, but now that card decks are no longer used for communicating with computers, card-punch machines are considered useless. Based on this analogy, *System Quality* (of which Ease of Use is a central component) is unlikely to be influenced by the importance of the system to the user, i.e., *User Involvement*.

Similarly, we argue that *Information Quality* is unlikely to be influenced by *User Involvement*. *Information Quality* is concerned with the timeliness, accuracy, relevance, and format of information generated by an information system. These are relatively objective qualities of information and it seems unlikely that a user will judge *Information Quality* to be high simply because he or she thinks the task performed by the system is important.

We therefore expect *User Involvement* will be positively associated with both *Usefulness* and *Satisfaction* but not with *System Quality* and *Information Quality*. These expectations are shown as hypotheses 6 and 7 in Figure 2.

H6: Increases in *User Involvement* will cause increases in *Usefulness*

H7: Increases in *User Involvement* will cause increases in *User Satisfaction*

Surveying the literature for support for these hypotheses, we found two papers of particular interest. First, in their empirical study, Jackson, Chow, and Leitch (1993) studied factors affecting behavioral intention to use an information system. They used Zaichkowski's (1985) Involvement instrument to measure *User Involvement* and found a highly significant relationship between *User Involvement* and *Perceived Usefulness* (t-statistic = 6.52). There are some difficulties with the use of all items in Zaichkowski's Involvement instrument in testing the relationship between *User Involvement* and *Usefulness* because some items in Zaichkowski's instrument actually measure *Usefulness* directly. Nonetheless, the large t-statistic in the Jackson, Chow and Leitch study provides considerable *empirical* support for the use of *User Involvement* to explain variance in *Perceived Usefulness* (H6).

Second, Kappelman and McLean (1991) used the same Zaichkowski instrument to investigate the relationship between *User Involvement* and *User Satisfaction*. They report a highly significant association ($p < 0.001$). This provides *empirical* support for our hypothesis 7.

3. TESTING THE MODEL OF USER SATISFACTION SHOWN IN FIGURE 2

To test the model in Figure 2, we prepared a questionnaire based on a number of standard instruments (details below). After ten face-to-face trials, the questionnaire was mailed to all users who had completed the training course for our university's recently-implemented Departmental Accounting System (DAS). We chose this particular system for data collection because we knew there had been some difficulties with its implementation and a wide range of *Usefulness* and *Satisfaction* scores was likely.[9] A second attraction was that the same system was in use in all departments and all users had been trained by the same trainers. There were therefore a smaller number of factors that could cause variance in the *Usefulness* and *Satisfaction* scores.

Details of all questions used in measuring variables for this study are presented in the appendix. The eight questions on *System Quality* are based on Doll and Torkzadeh's two questions on Ease of Use, four of Davis's questions on Perceived Ease of Use, plus three additional questions — all phrased in present (not future) tense. The ten questions on *Information Quality* are all from Doll and Torkzadeh. The four questions on *Overall Satisfaction* are from Seddon and Yip. The six questions on *Perceived Usefulness* are from Davis. Finally, the ten questions on *User Involvement* are a combination of two of our own questions, two from Lawler and Douglas (1970) on intrinsic motivation, and six from Zaichkowski via Kappelman and McLean.[10]

A total of 169 questionnaires were sent out, to all trained DAS users; 144 were returned, a response rate of 85%. Of these, only 104 were useful for data analysis. Non-useable responses were for the following reasons: some departments were not yet using DAS, some trained users were on leave, some were no longer responsible for DAS, and some had resigned. For each of the 38 questions asked, responses from early and late respondents (83 and 21 respondents, respectively) were compared using Goodman-Kruskal's gamma statistic (Siegel and Castellan 1988). None of the gamma statistics from these 38 questions indicated a significant difference, at the 5% level, between early and late respondents. Because of the high response rate and the lack of significant differences between early and late respondents, non-response bias is not considered a problem for this study.

Descriptive statistics for distributions of responses, tests of reliability, and the first two eigenvalues from factor analysis for each variable are given in Table 1. Pearson and Spearman correlation matrices for the variables are shown in Table 2. Results from path analysis are reported in Table 3 and in Figure 3. These were computed using two ordinary least squares linear regressions, the first with Usefulness as the dependent variable (Hypotheses 3, 4, and 6), and the second with User Satisfaction as the dependent variable (Hypotheses 1, 2, 5, and 7). Because the data are not normally distributed, the full sample of 102 cases (after deleting two cases with missing values) was split randomly into two samples of 51 observations. Results from analyses of these two half-samples are also shown in Table 3. They give a crude (and for H2 and H4 a somewhat alarming) indication of the stability of the path coefficients. (The R^2s for these subsample regressions are high, so multi-collinearity may be causing some instability.)

The results in the n = 102 column of Table 3 provide quite strong support for five of the hypotheses in Figure 2. The t-statistics are so large that we have confidence in rejecting the null hypotheses (of no association between the constructs) for hypotheses 1, 2, 3, 5, and 6. Support for hypothesis 4 is weak, and after controlling for the effect of *Involvement* on *Usefulness* there is no support for hypothesis 7. With the benefit of hindsight, one can see that the lack of significance in hypothesis 7 is consistent with the difficulties with our theoretical analysis in section 2.4. Perhaps Kappelman and McLean's correlation was so highly significant ($p < 0.001$) because the systems they studied were all working well — the (*Involvement* up, *Satisfaction* up) case discussed in section 2.4.

4. CONCLUSIONS AND DIRECTIONS FOR FURTHER RESEARCH

Our results provide considerable support for the DeLone and McLean model of IS success. In effect, the DeLone and McLean model may be interpreted as saying that User Satisfaction will respond to three types of user aspiration for information systems: Information Quality (H1), System Quality (H2), and Usefulness (H5). As they predicted, these three factors explained a large proportion of variance in User Satisfaction (72% in this study).

However, even after extending the DeLone and McLean model to include User Involvement, the model in Figure 2 was only able to explain 54% of the variance in Usefulness. More work is therefore needed to improve our understanding of factors that determine Usefulness. In section 2 of this paper, we argued that Usefulness would be determined by user perceptions of the value. This in turn, we argued, would be determined by (i) the perceived importance and personal relevance of the system (User Involvement) and (ii) the ease of use of the system (System Quality). The empirical evidence from our tests supports these predictions. User Involvement (H6) and System Quality (H3) were the two most significant variables in explaining Usefulness. In addition, as DeLone and McLean had predicted, Information Quality (H4) also made some contribution to user perceptions of Usefulness.

Table 1. Descriptive Statistics

VARIABLE	MEAN	STD. DEV.	SKEWNESS	KURTOSIS	MINIMUM	FREQ.	MAXIMUM	FREQ.
SATISFAC	4.675	1.567	-.578	-.299	1.000	5	7.000	6
USEFUL	3.919	1.881	-.049	-1.006	1.000	15	7.000	8
INVOLV	3.984	1.397	-.009	-.417	1.000	3	7.000	1
SYSQUAL	4.285	1.371	-.021	-.861	1.250	1	6.875	1
INFQUAL	4.685	1.296	-.325	-.536	1.600	1	7.000	2

VARIABLE	CRONBACH ALPHA	FIRST EIGENVALUE (CUM % OF VAR)		SECOND EIGENVALUE (CUM % OF VAR)		VARIABLE NAME
SATISFAC	0.91	3.16	(79.2%)	0.37	(88.6%)	*User Satisfaction*
USEFUL	0.99	5.61	(93.6%)	0.17	(96.4%)	*Usefulness*
INVOLV	0.91	5.66	(56.6%)	0.99	(66.5%)	*User Involvement*
SYSQUAL	0.92	5.31	(66.4%)	0.80	(76.5%)	*System Quality*
INFQUAL	0.95	6.98	(69.8%)	0.74	(77.3%)	*Information Quality*

Table 2. Correlation Matrix
(Pearson below the diagonal, Spearman above)

	SATISFAC	USEFUL	INVOLV	SYSQUAL	INFQUAL
SATISFAC	1.0000	.6960	.4594	.7107	.7167
USEFUL	.7145	1.0000	.5754	.6234	.4787
INVOLV	.4558	.6175	1.0000	.4124	.3223
SYSQUAL	.7009	.6191	.4211	1.0000	.5428
INFQUAL	.7302	.5005	.3269	.5468	1.0000

(all significant at p = < 0.001)

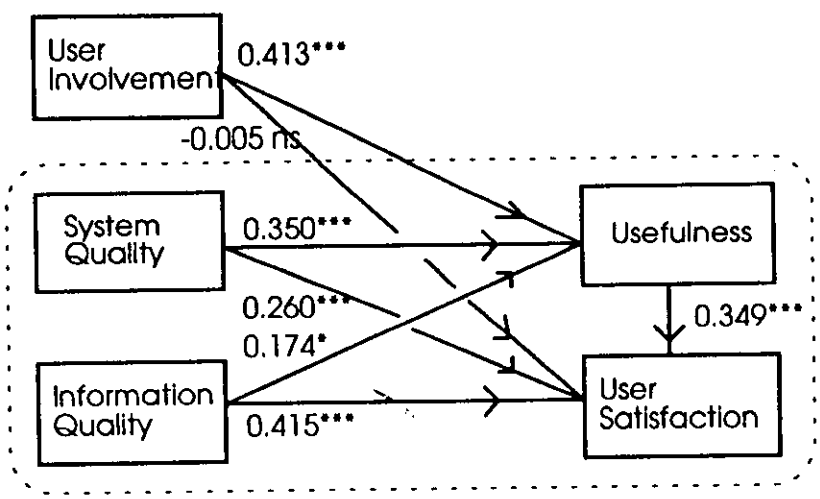

Figure 3. Results of Path Analysis (n = 102)
(*User Involvement* is defined by Barki and Hartwick [1989])
Significance levels: ***p < 0.001, **p < 0.01, *p < 0.05)

Table 3. Path Coefficients for the Model in Figure 2

	Path		Full sample (n=102)	Random half sample (n=51)	Remaining half (n=51)
	from	to			
H1	Information Quality	User Satisfaction	0.415 (6.444) ***	0.312 (3.476) ***	0.515 (5.422) ***
H2	System Quality	User Satisfaction	0.260 (3.656) ***	0.437 (4.081) ***	0.102 (1.031) ns
H3	System Quality	Usefulness	0.350 (4.156) ***	0.444 (4.102) ***	0.287 (2.297) *
H4	Information Quality	Usefulness	0.174 (2.155) *	-0.040 (-0.377) ns	0.367 (3.187) **
H5	Usefulness	User Satisfaction	0.349 (4.433) ***	0.280 (2.259) *	0.343 (3.146) **
H6	User Involvement	Usefulness	0.413 (5.543) ***	0.549 (5.786) ***	0.285 (2.547) **
H7	User Involvement	User Satisfaction	-0.005 (-0.071) ns	0.003 (0.031) ns	0.052 (0.587) ns
R^2 for regression with Usefulness as dependent variable			0.559 (Adj.=0.544)	0.643	0.555
R^2 for regression with User Satisfaction as dependent variable			0.732 (Adj.=0.721)	0.743	0.751

t-statistics in brackets, all one-tailed tests because all path coefficients are expected to be positive.
*** $p < 0.001$, ** $p < 0.01$, * $p < 0.05$

If you are looking for a short, simple measure of IS success, which one should you choose? Since Satisfaction is the most inclusive of the four perceptual measures investigated in this study, we recommend using User Satisfaction as the most general-purpose *perceptual* measure of system success. The four questions from Seddon and Yip, which returned reliability coefficients (alpha) of 0.95 in their survey and 0.91 in this study, may be all that are needed. Researchers wanting to *explain* variance in Overall Satisfaction, e.g., using OLS regression, should measure at least the three causal constructs suggested by our slightly-modified DeLone and McLean model, namely, Information Quality, System Quality, and Usefulness.

The four constructs we have examined from the DeLone and McLean model seem likely to be meaningful in a wide range of information system applications. Future research could try to identify other general factors that cause variance in Usefulness, User Satisfaction, or both. For example, if our understanding of the concept of Usefulness is correct, i.e., that usefulness is a judgement based on value but not cost, an additional measure that might explain further variance in Satisfaction is cost-effectiveness. It is also possible that different factors will have different weightings in different environments and with different types of systems, so replications of this study in other environments with other information systems would be useful.

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8. ENDNOTES

1. Melone (1990) provides a detailed discussion of the relationships between use, satisfaction, and IS effectiveness that considers the right-hand constructs in Figure 1a in more depth.

2. *User Involvement* should not be confused with *User Participation* — see Barki and Hartwick (1989, 1994).

3. Ives, Olson and Baroudi called User Participation "User Involvement," but following Barki and Hartwick (1989) the term used in this paper is "User Participation." Our *User Involvement* construct, used in hypotheses 6 and 7 later in this paper is also as defined by Barki and Hartwick (1989, 1994).

4. These four questions (as they apply to DAS, the system for which data were collected for this study) are reproduced as Part C in the Appendix to this paper.

5. Such high correlations of multi-factor measures and overall satisfaction measures are not uncommon. Bailey and Pearson (1983, p.536) report a correlation of 0.79 between their normalized importance-weighted measure of user satisfaction (based on up to 39 questions) and their single-scale measure of Overall "Self-assessed" Satisfaction.

6. Support is "limited" because in addition to asking questions similar to our questions 6, 7, 8, and 9 on Information Quality (see the appendix) under the heading "Information Quality," Kraemer et al. also asked whether "the computer makes new information available to me that was not previously available." This idea, which was absent from our study, appears to have been the most significant factor in their regression (their Table 7, p. 141).

7. Davis (1989, p. 320) expresses the same idea when he says something is useful if it is "capable of being used advantageously."

8. Goodhue (1986) makes the point that *Usefulness* (which he calls IS Satisfactoriness) is a belief (a relatively objective judgement about whether a tool can assist with the job), whereas *Satisfaction* is an attitude (a "predisposition to respond favorably or unfavorably to" the system [Melone 1990]).

9. This opinion proved to be correct. Mean User Satisfaction scores for data from this study were 4.68 (s.d. 1.57) on a scale from 1 to 7. Mean scores when Seddon and Yip (1992) used the same instrument to measure User Satisfaction with commercial general ledger systems was 5.56 (s.d. 1.16). Our users were significantly less satisfied.

10. If Barki and Hartwick's (1994) instrument for measuring *User Involvement* had been available at the time of the study, we would have used it. Note that they too excluded scales such as Useful/Useless and Worthless/Valuable from Zaichkowski's instrument because they do not measure Importance or Personal Relevance.

APPENDIX

DEPARTMENTAL ACCOUNTING SYSTEM (DAS) EVALUATION QUESTIONNAIRE

Please circle the appropriate number

Part A: System Quality.	*strongly agree*						*strongly disagree*
1. DAS is easy to use.	*1*	*2*	*3*	*4*	*5*	*6*	*7*
2. DAS is user friendly.	*1*	*2*	*3*	*4*	*5*	*6*	*7*
3. Compared to other computer software, DAS is easy to learn.	*1*	*2*	*3*	*4*	*5*	*6*	*7*
4. I find it easy to get DAS to do what I want it to do.	*1*	*2*	*3*	*4*	*5*	*6*	*7*
5. It is easy for me to become skilful at using DAS.	*1*	*2*	*3*	*4*	*5*	*6*	*7*
6. I believe that DAS is cumbersome to use.	*1*	*2*	*3*	*4*	*5*	*6*	*7*
7. My using DAS require a lot of mental effort.	*1*	*2*	*3*	*4*	*5*	*6*	*7*
8. Using DAS is often frustrating.	*1*	*2*	*3*	*4*	*5*	*6*	*7*

Part B: Information Quality. For the system overall,	*never*						*always*
1. Do you think the output is presented in a useful format?	*1*	*2*	*3*	*4*	*5*	*6*	*7*
2. Are you satisfied with the accuracy of the system?	*1*	*2*	*3*	*4*	*5*	*6*	*7*
3. Is the information clear?	*1*	*2*	*3*	*4*	*5*	*6*	*7*
4. Is the system accurate?	*1*	*2*	*3*	*4*	*5*	*6*	*7*
5. Does the system provide sufficient information?	*1*	*2*	*3*	*4*	*5*	*6*	*7*
6. Does the system provide up-to-date information?	*1*	*2*	*3*	*4*	*5*	*6*	*7*
7. Do you get the information you need in time?	*1*	*2*	*3*	*4*	*5*	*6*	*7*
8. Does the system provide reports that seem to be just about exactly what you need?	*1*	*2*	*3*	*4*	*5*	*6*	*7*
9. Does the system provide the precise information you need?	*1*	*2*	*3*	*4*	*5*	*6*	*7*
10. Does the information content meet your needs?	*1*	*2*	*3*	*4*	*5*	*6*	*7*

Part C: Overall Satisfaction.

On the following scales, please circle the number which best reflects your overall satisfaction with DAS.

1. How adequately do you feel DAS meets the information processing needs of your area of responsibility?	*adequate*	*1*	*2*	*3*	*4*	*5*	*6*	*7*	*inadequate*
2. How efficient is DAS?	*efficient*	*1*	*2*	*3*	*4*	*5*	*6*	*7*	*inefficient*
3. How effective is DAS?	*effective*	*1*	*2*	*3*	*4*	*5*	*6*	*7*	*ineffective*
4. Overall, are you satisfied with DAS?	*dissatisfied*	*1*	*2*	*3*	*4*	*5*	*6*	*7*	*satisfied*

Part D: Perceived Usefulness.

On the following scales, please circle the number that best reflects how useful you perceive DAS to be.

	strongly agree						*strongly disagree*
1. Using DAS in my job enables me to accomplish my tasks more quickly.	*1*	*2*	*3*	*4*	*5*	*6*	*7*
2. Using DAS improves my job performance.	*1*	*2*	*3*	*4*	*5*	*6*	*7*
3. Using DAS in my job increases my productivity.	*1*	*2*	*3*	*4*	*5*	*6*	*7*
4. Using DAS enhances my effectiveness in the job.	*1*	*2*	*3*	*4*	*5*	*6*	*7*
5. Using DAS makes it easier to do my job.	*1*	*2*	*3*	*4*	*5*	*6*	*7*
6. Overall, I find DAS useful to my job.	*1*	*2*	*3*	*4*	*5*	*6*	*7*

Part E: Your Involvement with DAS.

The following questions measure your involvement with DAS. Please circle the appropriate number.

	strongly agree						*strongly disagree*
1. I feel a sense of ownership for DAS in my department.	*1*	*2*	*3*	*4*	*5*	*6*	*7*
2. Most of my interests at work are centered around DAS.	*1*	*2*	*3*	*4*	*5*	*6*	*7*
3. My work with DAS							
a) contributes to my personal growth and development.	*1*	*2*	*3*	*4*	*5*	*6*	*7*
d) increases my feelings of self-esteem.	*1*	*2*	*3*	*4*	*5*	*6*	*7*

4. For me personally, in my job, DAS is

unimportant	*1*	*2*	*3*	*4*	*5*	*6*	*7* *important*
relevant	*1*	*2*	*3*	*4*	*5*	*6*	*7* *irrelevant*
trivial	*1*	*2*	*3*	*4*	*5*	*6*	*7* *fundamental*
interesting	*1*	*2*	*3*	*4*	*5*	*6*	*7* *boring*
appealing	*1*	*2*	*3*	*4*	*5*	*6*	*7* *unappealing*
mundane	*1*	*2*	*3*	*4*	*5*	*6*	*7* *fascinating*