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The DeLone and McLean Model of Information Systems Success: A Ten-Year Update

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ABSTRACT: Ten years ago, we presented the DeLone and McLean Information Systems (IS) Success Model as a framework and model for measuring the complex-dependent variable in IS research. In this paper, we discuss many of the important IS success research contributions of the last decade, focusing especially on research efforts that apply, validate, challenge, and propose enhancements to our original model. Based on our evaluation of those contributions, we propose minor refinements to the model and propose an updated DeLone and McLean IS Success Model. We discuss the utility of the updated model for measuring e-commerce system success. Finally, we make a series of recommendations regarding current and future measurement of IS success.

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THE MEASUREMENT OF INFORMATION SYSTEMS (IS) success or effectiveness is critical to our understanding of the value and efficacy of IS management actions and IS investments. In 1992, we published a paper [8] in which we attempted to bring some awareness and structure to the "dependent variable"—IS success—in IS research. We proposed a taxonomy and an interactive model (hereafter referred to as the "D&M IS Success Model") as frameworks for conceptualizing and operationalizing IS success. Since then, nearly 300 articles in refereed journals have referred to, and made use of, this IS Success Model. The wide popularity of the model is strong evidence of the need for a comprehensive framework in order to integrate IS research findings.

The D&M IS Success Model, though published in 1992, was based on theoretical and empirical IS research conducted by a number of researchers in the 1970s and 1980s. The role of IS has changed and progressed during the last decade. Similarly, academic inquiry into the measurement of IS effectiveness has progressed over the same period. We reviewed more than 100 articles, including all the articles in *Information Systems Research, Journal of Management Information Systems,* and *MIS Quarterly* since 1993 in order to inform this review of IS success measurement. The purpose of this paper, therefore, is to update the D&M IS Success Model and evaluate its usefulness in light of the dramatic changes in IS practice, especially the advent and explosive growth of e-commerce.

The D&M IS Success Model

THE PRIMARY PURPOSE OF THE ORIGINAL DeLone and McLean paper [8] was to synthesize previous research involving IS success into a more coherent body of knowledge and to provide guidance to future researchers. Based on the communications research of Shannon and Weaver [43] and the information "influence" theory of Mason [31], as well as empirical management information systems (MIS) research studies from 1981–87, a comprehensive, multidimensional model of IS success was postulated. Shannon and Weaver defined the *technical* level of communications as the accuracy and efficiency of the communication system that produces information. The *semantic* level is the success of the information in conveying the intended meaning. The *effectiveness* level is the effect of the information on the receiver. In the D&M IS Success Model, "systems quality" measures technical success; "information quality" measures semantic success; and "use, user satisfaction, individual impacts," and "organizational impacts" measure effectiveness success. In spite of the passage of time since the Shannon and Weaver framework in 1949 and Mason's extensions in 1978, both appear as valid today as when we adopted them a decade ago.

Based on both process and causal considerations, these six dimensions of success are proposed to be interrelated rather than independent. This has important implications for the measurement, analysis, and reporting of IS success in empirical studies. A *temporal, process* model suggests that an IS is first created, containing various features, which can be characterized as exhibiting various degrees of system and information quality. Next, users and managers experience these features by using the system and are either satisfied or dissatisfied with the system or its information products. The use of the system and its information products then impacts or influences the individual user in the conduct of his or her work, and these individual impacts collectively result in organizational impacts. The resultant D&M IS Success Model is reproduced in Figure 1 [8, p. 87].

In contrast to a process model, a *causal* or *variance* model studies the covariance of the success dimensions to determine if there exists a causal relationship among them. For example, higher system quality is expected to lead to higher user satisfaction and use, leading to positive impacts on individual productivity, resulting in organizational productivity improvements. The purpose of combining the success taxonomy with the success model was to aid in the understanding of the possible causal interrelationships among the dimensions of success and to provide a more parsimonious exposition of the relationships. Unhappily, for some critics this combination has proved troublesome, leading them to suggest a number of reformulations. These will be discussed later in this paper.

The primary conclusions of the original paper were:

1. The multidimensional and interdependent nature of IS success requires careful attention to the definition and measurement of each aspect of this dependent variable. It is important to measure the possible interactions among the success dimensions in order to isolate the effect of various independent variables with one or more of these dependent success dimensions.
2. Selection of success dimensions and measures should be contingent on the objectives and context of the empirical investigation; but, where possible, tested and proven measures should be used.
3. Despite the multidimensional and contingent nature of IS success, an attempt should be made to reduce significantly the number of different measures used to measure IS success so that research results can be compared and findings validated.
4. More field study research should investigate and incorporate organizational impact measures.
5. Finally, "[t]his success model clearly needs further development and validation before it could serve as a basis for the selection of appropriate IS measures" [8, p. 88].

Model Adoption

RESEARCH ADOPTION OF THE D&M IS SUCCESS MODEL has exceeded our expectations. A citation search in the summer of 2002 yielded 285 refereed papers in journals

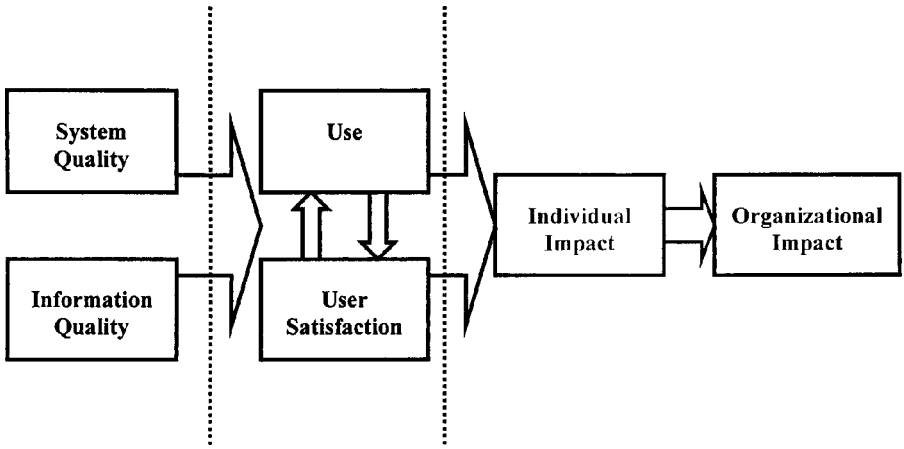

Figure 1. D&M IS Success Model.
Reprinted by permission, W. DeLone and E. McLean, Information Systems Success: The Quest for the Dependent Variable. *Information Systems Research,* 3(1), 1992, pp. 60–95. Copyright 1992, The Institute of Management Sciences (now INFORMS), 901 Elkridge Landing Road, Suite 400, Linthicum, MD 21090 USA.

and proceedings that have referenced the D&M Model during the period 1993 to mid-2002. Many of these articles positioned the measurement or the development of their dependent variable(s) within the context of the D&M IS Success framework. By using the model as a common framework for reporting and comparing research work involving IS success or effectiveness, we believe one of the primary purposes of the original article has been achieved.

Although many of the cited articles tended to justify their empirical measurement of IS success by citing the D&M IS Success Model, some of them failed to heed our cautions. Some researchers have used the model to support their chosen success variable rather than to inform the development of a more comprehensive success construct. They overlooked the main conclusion of the article—that IS success is a multidimensional and interdependent construct—and that it is therefore necessary to study the interrelationships among, or to control for, those dimensions. "Researchers should systematically combine individual measures from the IS success categories to create a comprehensive measurement instrument" [8, pp. 87–88]. Although these authors did not choose to measure (or control for) the various dimensions of IS success, a number of other researchers have used multidimensional measures of IS success in their empirical studies and have analyzed the interrelationships among them. Some of these studies are summarized in the next section.

Model Validation

UNLIKE A PROCESS MODEL, which merely states that B *follows* A, a causal model postulates that A *causes* B; that is, increasing A will cause B to increase (or decrease).

In the 1992 article we proposed such interrelationships among the dimensions in our model; but we did not test them empirically. Since 1992, a number of studies have undertaken empirical investigations of the multidimensional relationships among the measures of IS success.

Empirical testing and validation of the D&M IS Success Model was the primary purpose of two research studies [38, 41]. Seddon and Kiew [41] surveyed 104 users of a recently implemented, university accounting system and found significant relationships between "system quality" with "user satisfaction" and "individual impact," between "information quality" with "user satisfaction" and "individual impact," and between "user satisfaction" and "individual impact." Rai et al. [38] performed a goodness-of-fit test on the entire D&M IS Success Model based on survey responses from 274 users of a university student IS. The study found that some goodness-of-fit indicators were significant but others were not. However, *all* of the path coefficients among success dimensions of the D&M IS Success Model were found to be significant.

Other empirical studies explicitly tested the associations among the measures identified in the D&M IS Success Model [10, 12, 14, 16, 22, 50]. Yet other empirical studies have implicitly tested the model by investigating multiple success dimensions and their interrelationships [11, 17, 48, 52, 54, 57, 58, 60]. Figure 2 displays the D&M IS Success Model and the relationships confirmed (or not confirmed) in the 16 empirical studies cited above. These studies were selected based on the fact that they used multidimensional success constructs and they measured the association among the success constructs. In the following paragraphs, these empirical results are summarized by the success links that were tested. Links with the strongest empirical support are discussed first.

System Use—Individual Impacts

Seven of the 16 studies in Figure 2 [12, 14, 16, 48, 52, 54, 60] tested the association between "system use" and "individual impacts" and the association was found to be significant in each of the studies. System use was typically voluntary and was measured as frequency of use, time of use, number of accesses, usage pattern, and dependency. Individual impacts were measured in terms of job performance and decision-making performance.

System Quality—Individual Impacts

All five studies [10, 12, 41, 50, 57] that tested the direct association between "system quality" and "individual impacts" found those associations to be statistically significant. System quality was measured in terms of ease-of-use, functionality, reliability, flexibility, data quality, portability, integration, and importance. Individual impacts were measured as quality of work environment and job performance.

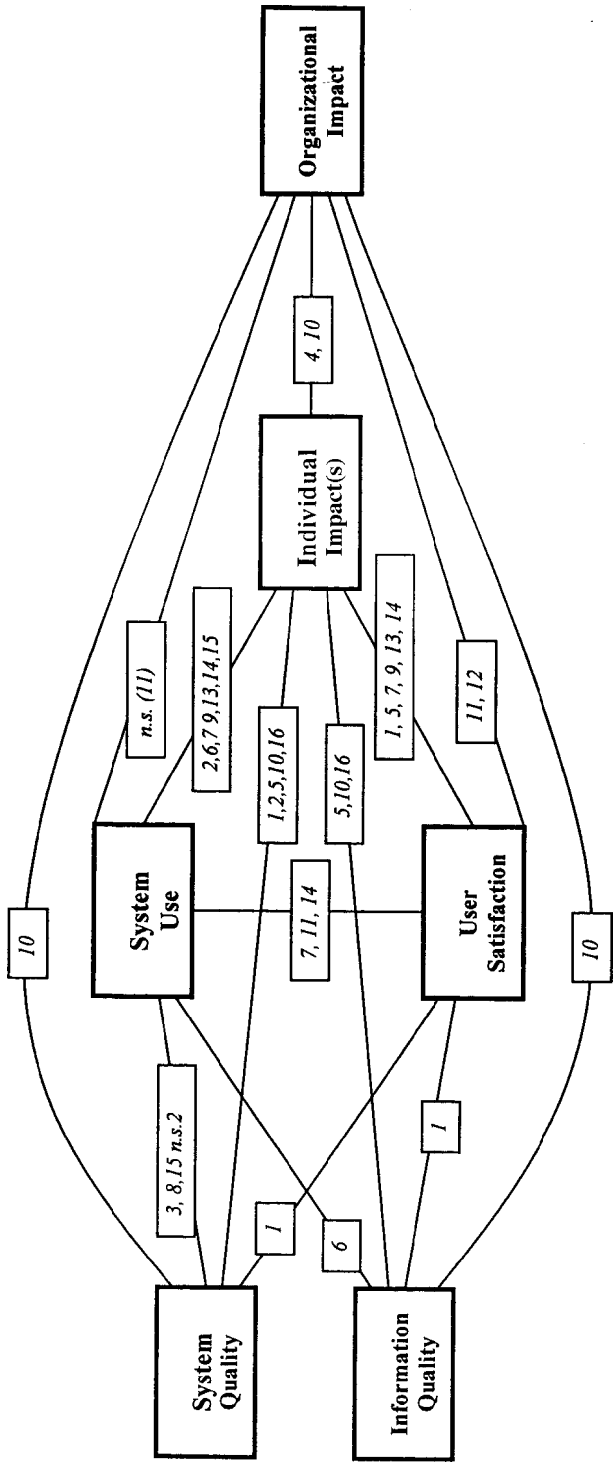

Figure 2. Dimension Association Tests.
(1) Seddon and Kiew [41]; (2) Goodhue and Thompson [12]; (3) Taylor and Todd [47]; (4) Jurison [22]; (5) Etezadi-Amoli and Farhoomand [10]; (6) Teng and Calhoun [48]; (7) Igbaria and Tan [16]; (8) Igbaria et al. [17]; (9) Guimaraes and Igbaria [14]; (10) Teo and Wong [50]; (11) Gelderman [11]; (12) Yoon et al. [58]; (13) Yuthas and Young [60]; (14) Torkzadeh and Doll [52]; (15) Weill and Vitale [54]; (16) Wixom and Watson [57].

Information Quality—Individual Impacts

The four studies [10, 41, 50, 57] that tested the relationship between "information quality" and "individual impacts" found the association to be significant. Information quality was measured in terms of accuracy, timeliness, completeness, relevance, and consistency. Individual impact was measured in terms decision-making performance, job effectiveness, and quality of work.

Other Links

With one exception, all the other links or associations in the D&M IS Success Model were empirically validated. The one empirical study that found the associations not significant was a survey of Dutch managers [11], where the association between system use and organizational revenues and profitability was not statistically significant.

In conclusion, 36 of the 38 success factor associations that were empirically tested in the 16 studies summarized in Figure 2 were found to be significant. Taken as a whole, these empirical studies give strong support for the proposed associations among the IS success dimensions and help to confirm the causal structure in the model.

Model Issues

IN ADDITION TO THE MANY PAPERS that have tested and validated the D&M IS Success Model, several articles have been published that challenge, critique, or extend the model itself. On balance, these articles have contributed to a better understanding of success and its dimensions. These articles and the issues they raise to the D&M IS Success Model are summarized below.

Process Versus Causal Models

The D&M IS success taxonomy and its six success categories are based on a process model of IS [43]. In addition, we argue that the six dimensions are interrelated, resulting in a success model that indicates that causality flows in the same direction as the information process. However, citing an earlier paper by Newman and Robey [35], Seddon argues that "the boxes and arrows in variance- and process-model diagrams represent quite different concepts and cannot be combined meaningfully in one model. . . . Unfortunately, combining variance and process models is exactly what [DeLone and McLean have] attempted to do" [40]. Seddon further argues that DeLone and McLean have "attempted to combine both process and causal explanations of IS success in their model. After working with this model for some years, it has become apparent that the inclusion of both variance and process interpretations in their model leads to so many potentially confusing meanings" [40, p. 240]. Seddon goes on to propose a respecified variance model of IS success.

We agree with Seddon's premise that the combination of process and variance interpretations of IS success in one model can be confusing. However, we believe that Seddon's reformulation of the D&M Model into two partial variance models [40, p. 245] unduly complicates the success model, defeating the intent of the original model.

The creation of the D&M IS Success Model was driven by a process understanding of IS and their impacts. This process model has just three components: the creation of a system, the use of the system, and the consequences of this system use. Each of these steps is a *necessary, but not sufficient, condition* for the resultant outcome(s). For instance, without system use, there can be no consequences or benefits. However, with system use, even extensive use, which is inappropriate or ill-informed, there may also be no benefits. Thus, to understand fully the dimensions of IS success, a variance model is also needed. Thus, as Seddon himself pointed out [40, 42], the application of our model to empirical research also requires a contextual variance specification of the model. Here too there are three components: the first is production, the second is use, and the third is net benefits. The only argument is whether these two necessary dimensions can be combined into one model. Along with Seddon, we believe that they can; only our formulations are different.

System Use as a Success Measure

Seddon [40] further argues for the removal of "system use" as a success variable in the causal success model, claiming that *use* is a behavior, appropriate for inclusion in a process model but not in a causal model. He argues that use must *precede* impacts and benefits, but it does not *cause* them. We disagree. We believe that system usage is an appropriate measure of success in most cases.

The problem to date has been a too simplistic definition of this complex variable. Simply saying that more use will yield more benefits, without considering the nature of this use, is clearly insufficient. Researchers must also consider the nature, extent, quality, and appropriateness of the system use. The nature of system use could be addressed by determining whether the full functionality of a system is being used for the intended purposes. Young and Benamati [59], for example, suggest that full functional use of an e-commerce system should include informational use, transactional use, and customer service use. With regard to the extent of use, Lassila and Brancheau [27] identify various states of systems utilization based on the use or nonuse of basic and advanced system capabilities. Simply measuring the amount of time a system is used does not properly capture the relationship between usage and the realization of expected results. On the other hand, it can be argued that *declining* usage may be an important indication that the anticipated benefits are not being realized.

The rejection of system use as a success variable when system usage is mandatory is also flawed for the reasons cited above. Even when use is required, variability in the quality and intensity of this use is likely to have a significant impact on the realization of the system benefits. Furthermore, no system use is totally mandatory. At some level of the organization, an executive or management committee has chosen to

implement a system and require employees to use it. Thus, whereas usage of a system may be mandatory at one level, the continued adoption and use of the system itself may be wholly voluntary, based upon management judgment, at a higher level. Management always has the option of discontinuing a system that is not providing the desired results and benefits.

System usage continues to be used as a dependent variable in a number of empirical studies and continues to be developed and tested by IS researchers [11, 12, 14, 16, 17, 38, 47, 48, 52, 54, 60]. System use has taken on new importance in e-commerce success measurements where customer use is voluntary and essential to desired outcomes [7, 29, 36]. "While most studies that follow D&M replace the *Use* box with *Usefulness* . . . , we prefer to maintain *Use* as in the original work. In e-commerce systems *Use* is largely voluntary" [33, p. 6]. We agree with these IS researchers and believe that use, *especially informed and effective use,* will continue to be an important indication of IS success for many systems.

Role of Context

Several researchers have commented on the difficulty of applying the D&M IS Success Model in order to define and operationalize IS success in specific research contexts. This was not unexpected: "This success model clearly needs further development and validation before it could serve as a basis for the selection of appropriate IS measures" [8, p. 88]. Jiang and Klein [20] found that users prefer different success measures, depending on the type of system being evaluated. Whyte et al. found that "there are important differences deriving from organizational, user, and systems variations which can modify the view as to which attributes (success measures) are important" [55, p. 65]. Seddon et al. [42] make an important contribution by proposing a two-dimensional matrix for classifying IS effectiveness measures based on the type of system studied and on the stakeholder in whose interest the IS is being evaluated. In this regard, we completely agree. As stated in the 1992 article, "no single variable is intrinsically better than another, so the choice of success variables is often a function of *the objective of the study, the organizational context* . . . etc." [8, p. 80, emphasis added].

Independent Versus Dependent Variables

Many of the suggested improvements to the D&M IS Success Model flow from a confusion between what is an independent variable and what is part of the dependent variable, IS success. "User involvement" and "top management support" are but two examples of suggested additions to the D&M Model; yet these are clearly variables that may *cause* success rather than being a part *of* success. "Investing in ERP" may (or may not) lead to improved "information quality" (an aspect of IS success), but the former is an independent variable whereas the latter is part of the dependent variable. It is essential that IS researchers distinguish between the management control variables and the desired results in terms of quality, use satisfaction, and impacts.

Model Extensions

Service Quality

THE EMERGENCE OF END USER COMPUTING in the mid-1980s placed IS organizations in the dual role of *information provider* (producing an information product) and *service provider* (providing support for end user developers). Pitt et al. observed that "commonly used measures of IS effectiveness focus on the products rather than the services of the IS function. Thus, there is a danger that IS researchers will mismeasure IS effectiveness if they do not include in their assessment package a measure of IS service quality" [37, p. 173]. Other researchers have agreed with this, citing the need for a service quality measure to be a part of IS success [25, 28, 56].

Researchers who have argued that service quality be added to the success model have applied and tested the 22-item SERVQUAL measurement instrument from marketing [25, 37] to an IS context. This instrument uses the dimensions of tangibles, reliability, responsiveness, assurance, and empathy to measure service quality. Some sample SERVQUAL instrument items include:

- "IS has up-to-date hardware and software" (tangible);
- "IS is dependable" (reliability);
- "IS employees give prompt service to users" (responsiveness);
- "IS employees have the knowledge to do their job well" (assurance); and
- "IS has users' best interests at heart" (empathy).

Van Dyke et al. [53] challenged this SERVQUAL metric, identifying "problems with the reliability, discriminant validity, convergent validity, and predictive validity of the measure. . . . [F]urther work is needed in the development of measures for assessing the quality of information services." Recently, Jiang et al.'s [21] empirical study among 168 users and 168 IS professionals concluded that the SERVQUAL measure is a valuable analytical tool for IS managers. The study found high convergent validity for the reliability, responsiveness, assurance, and empathy of the SERVQUAL scales and found acceptable levels of reliability and discriminant validity among the reliability, responsiveness, and empathy scales.

Whereas we agree that the SERVQUAL metric needs continued development and validation, we nevertheless believe that "service quality," properly measured, deserves to be added to "system quality" and "information quality" as components of IS success. Although a claim could be made that "service quality" is merely a subset of the model's "system quality," the changes in the role of IS over the last decade argue for a separate variable—the "service quality" dimension.

Of course, each of these quality dimensions will have different weights depending upon the level of analysis. To measure the success of a single system, "information quality" or "system quality" may be the most important quality component. For measuring the overall success of the IS department, as opposed to individual systems, "service quality" may become the most important variable. Once again, context should dictate the appropriate specification and application of the D&M IS Success Model.

Net Benefits

As the "impacts" of IS have evolved beyond the immediate user, researchers have suggested additional IS impact measures, such as work group impacts [18, 34], inter-organizational and industry impacts [5, 6], consumer impacts [3, 15], and societal impacts [40]. Clearly, there is a continuum of ever-increasing entities, from individuals to national economic accounts, which could be affected by IS activity. The choice of where the impacts should be measured will depend on the system or systems being evaluated and their purposes. Rather than complicate the model with more success measures, we prefer to move in the opposite direction and group all the "impact" measures into a single impact or benefit category called "net benefits." Although, for some studies, such finer granularity may be appropriate, we resisted such further refinements for the sake of parsimony. This is discussed further in the Analysis and Recommendations section.

Measurement Enhancements

TABLES 1 THROUGH 6 IN THE 1992 ARTICLE [8, pp. 65–83] listed the numerous success measures within each success category that had been used in previous empirical studies. We called for "a significant reduction in the number of dependent variable measures so that research results can be compared" [8, p. 80]. Since then, several studies have developed and tested survey instruments, which measure one or more of these six success constructs.

Based on a comprehensive literature review, Mirani and Lederer [32] developed a 33-item instrument to measure organizational benefits derived from IS projects. Their measurement framework consisted of three categories of organizational benefits: strategic, informational, and transactional. The proposed instrument was empirically tested in a survey of 200 IS managers and systems analysts. The results showed strong evidence of discriminant validity. Further analysis identified three subdimensions for each of the benefit categories. Strategic benefits were further subdivided into competitive advantage, alignment, and customer-relations benefits. Informational benefits included information access, information quality, and information flexibility subdimensions; and finally, transactional benefits included communication efficiency, systems development efficiency, and business efficiency subdimensions. We believe that validated instruments, such as this, that measure IS benefits are an important contribution to IS success measurement.

In a conceptual paper, Martinsons et al. [30] suggest an adaptation of the Kaplan and Norton "Balanced Scorecard" (BSC) [23] approach for the measurement of organizational performance. The BSC consists of four performance perspectives: the financial perspective, the customer perspective, the internal business process perspective, and the learning and growth perspective. Applied to an IS context, the authors propose a balanced IS scorecard to include a business-value measurement dimension, a user-orientation dimension, an internal-process dimension, and a future-readiness dimension. The authors then suggest specific measures related to each IS BSC dimension.

For example, cost control, revenue generation, strategic alignment, and return on investment are among the measures suggested for the business-value dimension.

Based on a literature review, Torkzadeh and Doll [52] developed a four-factor, 12-item instrument for measuring the individual impact of IS. A survey of 409 end users from 18 different organizations was used to test the measurement instrument. The overall reliability of the 12-item scale was 0.92. The empirical evidence also supports the convergent and discriminant validity of the instrument. The resulting individual impact dimensions are:

- Task productivity—the extent to which an application improves the user's output per unit of time;
- Task innovation—the extent to which an application helps users create and try out new ideas in their work;
- Customer satisfaction—the extent to which an application helps the user create value for the firm's internal or external customers; and
- Management control—the extent to which the application helps to regulate work processes and performance.

Using a 24-item impact measurement instrument, Jiang and Klein [20] surveyed 113 managers regarding systems impacts across three different system types: transaction processing systems (TPS), information reporting systems (IRS), and decision support systems (DSS). Their study found that users value decision quality impacts in DSS, but otherwise, value systems performance impacts for TPS and IRS. These findings suggest that different impact measures are appropriate for different types of systems.

There continues to be much use—and discussion—of the User Information Satisfaction (UIS) instrument [2, 19]. Saarinen [39] has developed an expanded user satisfaction instrument that adds development process and IS impact dimensions to the use and product quality dimensions of the traditional UIS instrument [2, 19]. His four-factor, 52-item user satisfaction instrument was developed and tested based on 48 completed IS development projects. Reliability and validity tests found the four satisfaction constructs had acceptable reliability and satisfactory validity. The resulting instrument may serve as a more comprehensive perceptual surrogate for IS success. Li [28] also proposed an extended information satisfaction instrument but did not test the instrument.

Other authors have identified problems with UIS [51] and have proposed an alternate satisfaction measure [44]. In spite of these criticisms, UIS continues to be the most commonly used and developed success measure; but, when used alone, it cannot fully measure IS success.

As indicated earlier, systems use continues to be a popular success measure [17, 26, 47, 48]. However, Straub et al. [46] studied 458 users of a voice mail system and found that self-reported systems usage and computer-recorded usage were not correlated. Their findings suggest that self-reported system usage and computer-recorded usage should both be measured in empirical studies because the two do not necessarily correlate with one another.

Based on a literature review, Doll and Torkzadeh [9] developed a multidimensional measure of systems usage based on the nature and purpose of a system. A 30-item system usage instrument was tested using 409 computer users from 18 organizations. The 30 items measure three underlying systems usage constructs: use for decision support, use for work integration, and use for customer service. The empirical results provided evidence of the instrument's reliability, validity, and general applicability. Researchers should consider adopting and applying this more comprehensive systems usage instrument.

Agarwal and Prasad [1] studied both initial system usage and intentions of future use and found that different factors affected initial use versus future use of the World Wide Web. Similarly, Karahanna et al. [24] found different factors were associated with intention to use windows between potential adopters and continuing users. These two empirical studies demonstrate that early use and continued use can differ.

System use is clearly a key variable in understanding IS success; but, too frequently, simple usage variables are used to measure this complex construct. More research such as cited above is needed to refine the multidimensionality of systems usage.

Information quality has proven to be strongly associated with system use and net benefits in recent empirical studies [38, 54, 57] and especially in the context of e-commerce systems [7, 29, 33, 36, 49]. According to Molla and Licker, "[A]lthough information has long been considered as an important asset to modern business, e-commerce has elevated content, i.e. information . . . to higher levels of significance" [33, p. 7]. Information quality measures that have been used in recent e-commerce studies [7, 33, 36] include accuracy, relevance, understandability, completeness, currency, dynamism, personalization, and variety. Researchers are strongly encouraged to include information quality measures as a critical dimension of their success measurement construct.

Other Success Frameworks

NOT ALL OF THE RESEARCHERS HAVE ATTEMPTED to critique or modify the D&M IS Success Model. Some have developed and proposed alternate frameworks for measuring IS effectiveness. Grover et al. used an alternative, theoretically based perspective (theory of organizational effectiveness) "to build a theoretically-based construct space for IS effectiveness which complements and extends the [DeLone & McLean] IS Success Model" [13, p. 178]. Based on unit-of-analysis and evaluation-type context dimensions, the authors created six IS effectiveness categories. The six effectiveness classes are infusion measures (i.e., "organizational impacts" in the D&M IS Success Model), market measures (not covered in the D&M IS Success Model), economic measures (i.e., "organizational impacts"), usage measures (i.e., "system use"), perceptual measures (i.e., "user satisfaction"), and productivity measures (i.e., "individual impact"). Their framework considers "system quality" and "information quality" to be antecedent effectiveness constructs, whereas the D&M IS Success Model considers them to be important dimensions of success itself. In summary, the Grover et al. [13] IS effectiveness framework serves to validate the D&M IS Success Model

from a theoretical perspective and suggests an area for extension, namely, market impacts. We include market or industry impacts in our updated model described later in this paper.

Smithson and Hirschheim [45] proposed a conceptual framework for IS evaluation and demonstrated its usefulness in practice by applying the framework to the evaluation of an outsourcing situation. Their framework presents various theoretical bases for IS evaluation organized into three "zones" of evaluation: efficiency, effectiveness, and understanding. Appropriate constructs or metrics could be drawn from the literature stream associated with each conceptual base; for example, software metrics, organizational behavior, sociology, cognitive psychology, and so on. This framework includes evaluation areas that overlap the D&M success dimensions, including hardware and software metrics ("system quality"), system usage, user satisfaction, cost-benefit analysis, and so on, but also suggests many other theoretical sources of IS evaluation measures. The authors provide a framework that is a source for identifying and developing IS evaluation measures rather than a single framework of success dimensions and their interrelationships (i.e., the D&M IS Success Model). Their framework does not specify actual success constructs and related measures. This makes the framework difficult to apply in practice. However, it does offer the researcher an alternative theoretical framework for developing IS evaluation schemes.

Analysis and Recommendations

AS DISCUSSED EARLIER, IT NOW SEEMS APPROPRIATE to add a third dimension, "service quality," to the two original system characteristics, "systems quality" and "information quality." Conversely, as discussed earlier, it appears more parsimonious to combine "individual" and "organizational impacts" into a single variable, "net benefits."

This new variable, "net benefits," immediately raises three issues that must be taken into account: what qualifies as a "benefit"? for whom? and at what level of analysis? In the original formulation of the D&M Model, the term "impact" was used. Seddon [40] used "consequences" and "net benefits" in his characterization of the outcomes. We have come to prefer the term "net benefits" ourselves because the original term "impacts" may be positive or negative, thus leading to a possible confusion as to whether the results are good or bad. Also, the inclusion of "net" in "net benefits" is important because no outcome is wholly positive, without any negative consequences. Thus, "net benefits" is probably the most accurate descriptor of the final success variable.

The second issue of concern is: benefits for whom—the designer, the sponsor, the user, or others? Different actors, players, or stakeholders may have different opinions as to what constitutes a benefit to them [42]. Thus, it is impossible to define these "net benefits" without first defining the context or frame of reference. The fact that the D&M Model does not define this context is a matter of detail, not of oversight. The focus of any proposed study must be defined. Our model may be useful to both Microsoft and the user community, but each may have a very different definition of what constitutes net benefits and thus IS success.

Finally, the level of analysis must be addressed [4, 42]. Are the benefits to be measured from the individual's perspective, his or her employer, or that of the industry or of the nation? Collapsing "individual" and "organizational impacts" into a single variable, "net benefits," does not make the problem go away. It merely transfers the need to specify the focus of analysis to the researcher.

Based on these considerations, we have updated the original D&M IS Success Model as a foundation for framing future IS empirical research.

The Updated D&M IS Success Model

BASED ON RESEARCH CONTRIBUTIONS since our original paper, and based on changes in the role and management of information systems, we have updated our original success model. The updated model is presented on Figure 3.

As discussed earlier, quality has three major dimensions: "information quality," "systems quality," and "service quality." Each should be measured—or controlled for—separately, because singularly or jointly, they will affect subsequent "use" and "user satisfaction."

Given the difficulties in interpreting the multidimensional aspects of "use"—mandatory versus voluntary, informed versus uninformed, effective versus ineffective, and so on—we suggest "intention to use" may be a worthwhile alternative measure in some contexts. "Intention to use" is an attitude, whereas "use" is a behavior. Substituting the former for the latter may resolve some of the process versus causal concerns that Seddon (1997) has raised. However, attitudes, and their links with behavior, are notoriously difficult to measure; and many researchers may choose to stay with "use," but hopefully with a more informed understanding of it.

As was true in the original formulation of the D&M Model, "use" and "user satisfaction" are closely interrelated. "Use" must precede "user satisfaction" in a *process* sense, but positive experience with "use" will lead to greater "user satisfaction" in a *causal* sense. Similarly, increased "user satisfaction" will lead to increased "intention to use," and thus "use."

As a result of this "use" and "user satisfaction," certain "net benefits" will occur. If the IS or service is to be continued, it is assumed that the "net benefits" from the perspective of the owner or sponsor of the system are positive, thus influencing and reinforcing subsequent "use" and "user satisfaction." These feedback loops are still valid, however, even if the "net benefits" are negative. The lack of positive benefits is likely to lead to decreased use and possible discontinuance of the system or of the IS department itself (e.g., wholesale outsourcing). The challenge for the researcher is to define clearly and carefully the stakeholders and context in which "net benefits" are to be measured.

The updated D&M IS Success Model includes arrows to demonstrate proposed associations among success dimensions in a process sense, but does not show positive or negative signs for those associations in a causal sense. The nature of these causal associations should be hypothesized within the context of a particular study. For example, in one instance a high-quality system will be associated with more use,

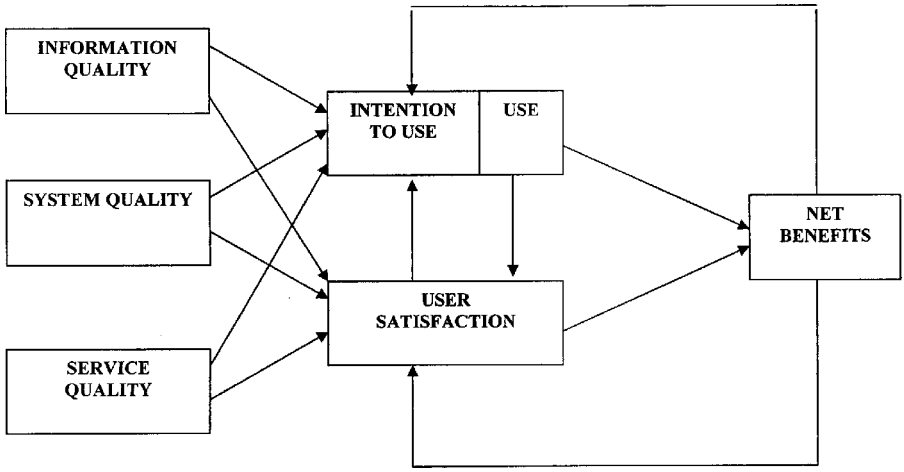

Figure 3. Updated D&M IS Success Model

more user satisfaction, and positive net benefits. The proposed associations would then all be positive. In another circumstance, more use of a poor quality system would be associated with more *dissatisfaction* and negative net benefits. The proposed associations would then be negative.

E-Commerce Success

INFORMATION TECHNOLOGY IN GENERAL, and the Internet in particular, is having a dramatic impact on business operations. Companies are making large investments in e-commerce applications but are hard-pressed to evaluate the success of their e-commerce systems. IS researchers have turned their attention to developing, testing, and applying e-commerce success measures [7, 29, 33, 36, 49]. Molla and Licker [33] proposed an e-commerce success model based on the D&M IS Success Model. This section demonstrates how the updated D&M IS Success Model can be adapted to the measurement challenges of the new e-commerce world.

As a powerful communications and commerce medium, the Internet is a communication and IS phenomenon that lends itself to a measurement framework (i.e., the D&M IS Success Model) that is built on communication theory (e.g., Shannon and Weaver [43]). Within the e-commerce context, the primary system users are customers or suppliers rather than internal users. Customers and suppliers use the system to make buying or selling decisions and execute business transactions. These electronic decisions and transactions will then impact individual users, organizations, industries, and even national economies. This communications and commerce process fits nicely into the updated D&M IS Success Model and its six success dimensions.

- "System quality," in the Internet environment, measures the desired characteristics of an e-commerce system. Usability, availability, reliability, adaptability,

and response time (e.g., download time) are examples of qualities that are valued by users of an e-commerce system.

- "Information quality" captures the e-commerce content issue. Web content should be personalized, complete, relevant, easy to understand, and secure if we expect prospective buyers or suppliers to initiate transactions via the Internet and return to our site on a regular basis.
- "Service quality," the overall support delivered by the service provider, applies regardless of whether this support is delivered by the IS department, a new organizational unit, or outsourced to an Internet service provider (ISP). Its importance is most likely greater than previously since the users are now our customers and poor user support will translate into lost customers and lost sales.
- "Usage" measures everything from a visit to a Web site, to navigation within the site, to information retrieval, to execution of a transaction.
- "User satisfaction" remains an important means of measuring our customers' opinions of our e-commerce system and should cover the entire customer experience cycle from information retrieval through purchase, payment, receipt, and service.
- "Net benefits" are the most important success measures as they capture the balance of positive and negative impacts of the e-commerce on our customers, suppliers, employees, organizations, markets, industries, economies, and even our societies. Have Internet purchases saved individual consumers time and money? Have the benefits such as larger markets, supply chain efficiencies, and customer responsiveness yielded positive net benefits for an organization? Have countries' investments in e-commerce infrastructure yielded a net positive growth in the gross national product? Have societal investments in e-commerce infrastructure and education reduced poverty? "Net benefits" measures must be determined by context and objectives for each e-commerce investment. Thus, there will be a variety of e-commerce "net benefits" measures, but many will be the same ones that have been developed and tested for IS investments in general.

"Net benefits" success measures are most important, but they cannot be analyzed and understood without "system quality" and "information quality" measurements. For example, within the e-commerce environment, the impact of a Web site design on customer purchases cannot be fully understood without an evaluation of the usability of the Web site and the relevance for purchasing decisions of the information that is provided to the prospective purchaser.

Table 1 demonstrates how the six dimensions of the updated D&M IS Success Model can be used as a parsimonious framework to organize the various success metrics identified in the IS and e-commerce literature.

Summary and Conclusions

TEN YEARS AGO WE PUBLISHED AN IS SUCCESS FRAMEWORK in order to integrate the research work on IS success that had been done up to that point and to provide

Table 1. E-Commerce Success Metrics

Systems quality
• Adaptability
• Availability
• Reliability
• Response time
• Usability
Information quality
• Completeness
• Ease of understanding
• Personalization
• Relevance
• Security
Service quality
• Assurance
• Empathy
• Responsiveness
Use
• Nature of use
• Navigation patterns
• Number of site visits
• Number of transactions executed
User satisfaction
• Repeat purchases
• Repeat visits
• User surveys
Net benefits
• Cost savings
• Expanded markets
• Incremental additional sales
• Reduced search costs
• Time savings

directions for future research. We presented an IS success model that attempted to capture the multidimensional and interdependent nature of IS success. The hundreds of research works that have applied, developed, challenged, or validated the original model speak to the need for a common approach to success measurement and to the value of a model for framing research designs. The succeeding ten years have seen tremendous progress in terms of the impacts of IS on business and society as well as progress in IS research. In light of this progress and change, we felt compelled to review, evaluate, and update our success model.

Considering the recent research studies that both validate and support our model as well as those that challenge it, we conclude that our original model and related con-

clusions [8] still form a sound basis for IS success measurement even in the e-commerce environment. We believe that our proposed changes in the updated D&M IS Success Model are largely changes in degree, not in kind. The addition of "service quality" and the collapsing of "individual impacts" and "organizational impact" into "net benefits" still preserve the parsimonious nature of the model.

Based on our review of the research experience of the last decade, we draw the following conclusions:

1. Many empirical studies have validated the original model and its interrelationships, whereas other studies have recommended enhancements to the original model. Based on these contributions, we propose an updated D&M IS Success Model to serve as a foundation for the positioning and comparing of IS empirical research. The model should continue to be tested and challenged. The changes introduced in this paper are examples of this continued growth and refinement. We encourage others to join in this effort.
2. The updated D&M IS Success Model is a useful model for developing comprehensive e-commerce success measures as demonstrated in Table 1.
3. We recommend that "service quality" be added as an important dimension of IS success given the importance of IS support, especially in the e-commerce environment where customer service is crucial.
4. The complex, multidimensional, and interdependent nature of IS success requires careful attention to the definition and measurement of each dimension of this dependent variable. It is important to measure the possible interactions among these success dimensions in order to isolate the effect of various independent variables with one or more of these dependent success dimensions. The updated D&M IS Success Model in Figure 3 presents the interdependent relationships that should continue to be considered and tested.
5. For each research endeavor, the selection of IS success dimensions and measures should be contingent on the objectives and context of the empirical investigation, but, where possible, tested and proven measures should be used. The Seddon et al. [42] context matrix is a valuable reference for selection of success measures based on context.
6. Despite the multidimensional and contingent nature of IS success, an attempt should be made to reduce significantly the number of measures used to measure IS success so that research results can be compared and findings validated. Some good progress has been made in this area as noted in the Measurement Enhancements section of this paper. Where possible, we advocate the application of existing, validated measures rather than the development of new measures.
7. With the growth of management support systems and the advent and development of e-commerce systems, voluntary systems use is more common today than it was a decade ago. We, therefore continue to advocate the inclusion of "System Use" as a critical dimension of IS success measurement. Actual use measures should be preferred to self-reported use measures. Also, usage

measures should capture the richness of use as a system phenomenon including the nature, level, and appropriateness of use, and should not simply measure the frequency of use.

8. Finally, more field-study research should investigate and incorporate "Net Benefits" measures. Yuthas and Young support this conclusion: "[E]xamining satisfaction and usage measures is not an acceptable alternative to measuring performance [i.e., Net Benefits] directly. Although the three variables are correlated, the relationships between them are not sufficiently strong to warrant their use as substitutes for one another" [60, p. 121]. Good progress has been made in the development and testing of "Net Benefits" measures on the individual, group, firm, industry, and national levels.

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