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Re-conceptualizing Information System Success: The IS-Impact Measurement Model *

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Abstract

This paper re-conceptualizes "information system success" as a formative, multidimensional index. Such a validated and widely accepted index would facilitate cumulative research on the impacts of IS, while at the same time provide a benchmark for organizations to track their IS performance. The proposed IS-Impact measurement model represents the stream of net benefits from an Information System (IS), to date and anticipated, as perceived by all key user groups. Model measures are formulated to be robust, economical, and simple, yielding results that are comparable across diverse systems and contexts, and from multiple user perspectives. The model includes four dimensions in two halves. The "impact" half measures benefits to date, or Individual- and Organizational Impact; the "quality" half uses System Quality and Information Quality as proxies for probable future impacts. Study findings evidence the necessity, additivity, and completeness of these four dimensions.

The validation study involved three separate surveys, including exploratory and confirmatory phases preceded by an identification survey. Content analysis of 485 qualitative impacts cited by 137 respondents from across 27 Australian Government Agencies that implemented SAP Financials in the late 90s, identified salient dimensions and measures. The resultant a-priori model ("pool" of 37 measures) was operationalized in the subsequent specification survey, yielding 310 responses across the same 27 agencies. The confirmation survey, employing 27 validated measures from the specification survey, was next conducted in a large university that had implemented ORACLE Financials. Confirmatory analysis of the 153 responses provides further strong evidence of model validity.

Keywords: IS-Impact; Formative Construct Validation; Nomological Net; Information System Success; Enterprise System; Measurement Model; Questionnaire Survey; Longitudinal Research; Analytic Theory; Measurement Index

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1. Introduction

Organizations make large investments in Information Systems (IS) expecting positive impacts to the organization. Investments in complex and costly contemporary IS, Enterprise Systems (ES) being the quintessence, are under increasing scrutiny and pressure to justify their value¹ (Markus et al., 2003). In practice, however, though often carefully rationalized in advance, IS investments are seldom systematically evaluated post-implementation (Thatcher and Oliver, 2001). When a post-implementation review occurs, its process and measures are often idiosyncratic and lacking credibility or comparability.

While the assessment of IS Success is consistently reported by organizational executives throughout the world as a key issue (e.g., Irani and Love, 2000, Thatcher and Oliver, 2001), there is little consensus among practitioners or researchers on how best to measure the impact of IS in organizations. Sabherwal et al. (2006, p.1849) observe, "Despite considerable empirical research, results on the relationships among constructs related to information systems (IS) success, as well as the determinants of IS Success, are often inconsistent." A range of concerns with past attempts to measure IS Success have been suggested, including poor measurement (e.g., incomplete or inappropriate measures) (DeLone and McLean, 1992, DeLone and McLean, 2002, DeLone and McLean, 2003, Gable, 1996, Melone, 1990), lack of theoretical grounding and, hence, lack of agreement on appropriate measures (Bonner, 1995, Myers et al., 1998), myopic focus on financial performance indicators (Ballantine et al., 1996, Kaplan and Norton, 1996), weaknesses in survey instruments employed (e.g., constructs lacking in validity), or inappropriate data collection approach (e.g., asking the wrong people, unrepresentative sample) (Seddon et al., 1999). Moreover, the lack of a commonly accepted index for a critical dependent variable compromises the comparability of study results and hinders the cumulative research tradition.

This paper consolidates and extends earlier work of the authors (Gable et al., 2003, Sedera and Gable, 2004) by reconceptualizing IS Success as a multidimensional phenomenon. It derives a robust, validated IS-Impact measurement model for evaluating IS that is simple yet generalizable and yields results that are highly comparable across time, stakeholders, different systems, and system contexts. The approach employs perceptual measures, its aim being to offer a common instrument that addresses all relevant system users in a holistic way. Such a validated and widely-accepted IS-Impact measurement model has both academic and practical value. It facilitates systematic operationalization of a main dependent variable in research (IS-Impact) and can serve as an important independent variable in other research (e.g., IS-Impact as antecedent of organizational performance). For IS management practice, it also provides a means to benchmark and track the performance of information systems in use.

The remainder of the paper is organized as follows. The second section reviews persistent issues with developing and using IS Success models and measures as reported in the literature. The third section presents the study's conceptual model. Section four describes the research design. Sections five and six present results of the two surveys conducted in the exploratory phase and results of preliminary model testing and refinement. The seventh section describes the third survey and the analyses conducted in the confirmatory phase. The concluding section summarizes main findings and study limitations and discusses implications for future research.

2. Issues with IS Success Models and Measurement

Research assessing the success of Information Systems (IS) has been ongoing for nearly three decades (DeLone and McLean, 1992, Lin and Shao, 2000, Martin, 1979, Myers et al., 1998, Shin, 2003). However, the scope and approach of these IS Success evaluation studies has varied, and there is little consensus on the appropriate measures of IS Success. This complicates comparisons of

¹ Measuring the impacts of Enterprise Systems takes on special importance since the costs and risks of these large technology investments can more than rival their potential payoffs.

results across studies and impedes the establishment of a cumulative research tradition (Sabherwal et al., 2006).

Though the development of IS Success models (e.g., DeLone and McLean, 1992, Shang and Seddon, 2002) has been an important contribution, construct validation issues and concerns have largely remained under-addressed until relatively recently. In particular, these studies have not carefully addressed the nature of these constructs as either formative or reflective. Recent work by Petter et al., (2007) suggests that there is a significant threat of mis-specifying and validating constructs as “reflective” (MacCallum and Browne, 1993) that on closer scrutiny are in fact “formative”.² They encourage reflection on the validity of many mainstream constructs employed in IS research over the past three decades and critique the almost universal conceptualization and validation of these constructs as reflective. They are politic in not citing specific infractions but, rather, list a range of studies and provide examples of constructs that have been “properly” specified as reflective or formative.

This study and paper proceed from the assumption that the impact of IS is multi-dimensional. With the objective of developing a formative measurement model of the impact of IS, we next discuss several weaknesses with prior IS Success measures.

2.1. Choice of IS Success Constructs

The DeLone and McLean (1992) IS Success model is most widely cited and has been a valuable contribution to our understanding of IS Success. They classified existing measures of success into six constructs – System Quality, Information Quality, Organizational Impact, Individual Impact, Satisfaction, and Use. They suggest that in order to develop a comprehensive measurement model and instrument for a particular context, the constructs and measures should be systematically selected considering contextual contingencies, such as organization size or structure, or the technology and the individual characteristics of the system. Regardless, few studies elaborate the rationale for their choice of success constructs and measures employed. Burton-Jones and Straub, (2006) introduced a two-step approach for selecting measures for a study. They emphasize the importance of considering the “structure” and “function” of measures, where structure refers to the selection of elements (dimensions) that are most relevant for the research model and context; and function refers to the selection of measures for the chosen elements that tie the constructs into a nomological network.

2.2. Mutual Exclusivity and Additivity of Success Measures

While some (Bailey and Pearson, 1983, Doll and Torkzadeh, 1988, Ives et al., 1983, Saarinen, 1996) suggest that the various success constructs studied (e.g., Information Quality, Individual Impact) offer surrogate, or perhaps alternative, measures of success, other researchers have suggested they represent distinct dimensions of a complex, higher-order phenomenon (Chandler, 1982, Ein-Dor and Segev, 1978). An analogous example of the latter view, to which we subscribe, is Gable’s study of 150 computer system selection projects involving external consultants, wherein he tested a multidimensional model of consultant engagement success (Gable, 1996). He found that these dimensions are mutually exclusive and additive and can be usefully combined to yield an overarching measure of success.

2.3. Model Completeness

In order to fully account for potentially countervailing constructs and measures of success (e.g., high quality but poor cost-effectiveness), model completeness is essential. Following a review of

² Reflective constructs have observed measures that are affected by an underlying latent, unobservable construct (MacCallum and Browne 1993), while formative constructs are a composite of multiple measures. A change in the reflective construct affects the underlying measures, while changes in the formative measures cause changes in the underlying formative construct. Misspecification of constructs as formative or reflective results in measurement error which impacts the structural model thereby increasing the potential for type I and type II errors.

alternative models from the literature, Melone (1990) highlights the subjectivity inherent in the selection of a single construct (as a proxy for overall success). This suggests that where the aim is to gain a full, overarching view of success, it is critical that the complete set of success constructs be employed, not a selected subset.

Gable (1996) suggests that the employment of only one or a subset of the dimensions of success as a surrogate for overall success may be one of the reasons for mixed results reported in the literature regarding the antecedents of success (Barki and Hartwick, 1989, Gatian, 1994, Hawk and Aldag, 1990, Ives and Olson, 1984, Myers et al., 1998). Review of the literature on DeLone and McLean identified 149 studies of IS Success measurement as depicted in Table 1.

Table 1: Empirical Studies of DeLone and McLean (1992-2005)			
# of constructs measured	Total Studies		
	#	%	Cumulative %
1	88	59%	59%
2	26	17%	77%
3	21	14%	91%
4	9	6%	97%
5	3	2%	99%
6	2	1%	100%
Total	149	100%	

From Table 1 we observe that approximately 60 percent of studies employing DeLone and McLean constructs use a single construct, with over 90 percent using three or less. This is not to suggest that any specific study employing less than the full set is flawed – one would have to consider the specific intent of each study (in fact, we do not advocate the full set). Rather, it is our contention that at least a portion of these studies has inappropriately and non-reflectively employed a subset of the constructs as an overarching measure of success. In light of the aforementioned infrequent attention to rationale for choice of constructs and given our concern with potential implications of an incomplete measure of overall success, this is a concern for advancing IS-Impact measurement.

2.4. Theoretical Basis for Causal/Process Paths

DeLone and McLean's model is critiqued for insufficient explanation of its underlying theory and epistemology, with many questioning the suggested causal/process nature of the model (Ballantine et al., 1996, Myers et al., 1998). Seddon, (1997) was the first to empirically test part of the causal structure, his investigation evidencing support for some model paths. Other researchers have since tested causal relationships between other of the six constructs, yielding mixed results (Bonner, 1995, Hunton and Flower, 1997). This lack of theoretical grounding, combined with the weak explanation for causality and mixed results from empirical studies, raises concerns about the validity of the suggested relationships.

2.5. The Nature of the Contemporary IS Environment

The transition from in-house, custom-made, stand-alone applications to integrated, customizable packages has changed the way organizations produce and manage information. New measures and evaluation models are required to gauge the success of contemporary IS (Ishman, 1996) such as Enterprise Systems (Ishman, 1996). Nonetheless, most IS Success studies continue to rely on instruments and measures that were validated with now non-existing and outdated information systems (Jurison, 1996, Saarinen, 1996).

Moreover, though IS investments are in many ways comparable to traditional investments such as production equipment, and it is a common tendency to evaluate IS only in terms of financial criteria, it is widely acknowledged that most IS result in considerable intangible impacts. Thus, the use of traditional financial measures alone does not fully account for evidence of IS benefits (Ballantine et al., 1996, Brynjolfsson, 1993).

2.6. Multiple Stakeholder Perspectives

The importance of analyzing IS Success at multiple levels within organizations has been discussed among academics for over a decade (Cameron and Whetten, 1983, Leidner and Elam, 1994, Quinn and Rohrbaugh, 1983, Sedera et al., 2006, Tallon et al., 2000, Thong and Yap, 1996, Yoon, 1995). The concern is that different employment cohorts have differing experience of the system. Yet, IS studies have, in the main, attempted to quantify the impacts of IS by analyzing data collected from only a single employment cohort.

In summary, we note that many of the issues listed in this section (section 2) have relevance to the appropriate specification and identification of IS Success as a formative construct; namely, the completeness, mutual exclusivity, and necessity of dimensions and measures. The study conceptual model discussed next attempts to address the aforementioned concerns by drawing upon, when possible, earlier IS Success studies, models, and measures.³

3. The Conceptual Model

Organizations evaluate their Information System (IS) for various reasons. Positive impacts are the ultimate outcome sought, their measure being the “acid-test” of the IS. A frequently asked question is, “Has the IS benefited the organization?” or “Has the IS had a positive impact?” (e.g., Melville et al., 2004). These questions seek a measure of net benefits⁴ or impacts to date. They look backward.

The IS, being a long-term investment, is expected (*ceteris paribus*) to yield a continuing flow of benefits into the future. Thus, other questions of interest include – “Is the IS worth keeping?”, “Does the IS need changing?” or “What future impacts will the IS deliver?” These questions look forward. We propose that the quality of an IS is arguably our best predictor of its probable future impact.

We thus argue that a holistic measure for evaluating an IS should consist of dimensions that together look both backward (impacts), and forward (quality). Figure 1 depicts the IS-Impact conceptual model wherein we see a nexus between Impacts to date and Quality.^{5 6} We define the **IS-Impact** of an Information System (IS) as a measure at a point in time of the stream of net benefits from the IS, to date and anticipated, as perceived by all key user groups. The IS-Impact Model is a holistic index representing the stream of net benefits; the impact half measuring net benefits to date, the quality half being our best proxy measure of probable future impacts, and “impacts” being the common denominator.

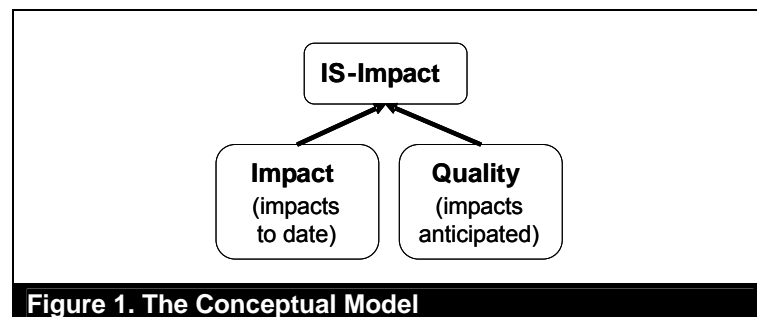


Figure 1. The Conceptual Model

³ The subsequent section also aligns with step one (structure) of the Burton-Jones and Straub (2006) two-step approach to construct operationalization.

⁴ Discussion on IS-Impact herein, both preceding and following, has assumed a decidedly organization-centric perspective — even at the Individual level, the impact of a system is measured to evaluate system-related benefits for the organization, e.g., individual productivity and effectiveness in the job.

⁵ A quality system and quality information are only of value to the extent that they promote satisfaction and appropriate use and ultimately positive impacts on the individual and the organization.

⁶ We note that this quality-impact distinction is similar to Alter's (as in Seddon et al., 1999) distinction between internal performance and external performance which respectively refer to how well the system operates internally versus how well the system achieves its purpose (1999, p.48), or which he also more simply refers to as the “system” versus “the system's performance” (1999, p.43).

The proposed IS-Impact model has some basis in the Benbasat and Zmud (2003) IS nomological net (IS-Net), wherein quality and impact have conceptual analogues, with quality being a measure of the IT-Artifact (see Appendix A for brief background on the IS-Net). Next, we reconcile DeLone and McLean (1992) with the IS-Net by demonstrating the recursive nature of both. We then conceptually position the IS-Impact constructs within this reconciled and recursive nomological net, thereby facilitating discussion on the importance of the timing of measurement and the appropriateness of cross-sectional measurement of the IS-Impact dimensions. This discussion serves to both justify the IS-Impact view conceptually and operationally.

3.1. Reconciling IS-Net and DeLone & McLean

Figure 2 depicts the IS-Net after having mapped in the six DeLone and McLean (1992) IS Success constructs (Appendix A includes Figure A.1 - The Original IS-Net). It is straightforward to employ System Quality and Information Quality as measures of the IT Artifact (the Information System); as it is to employ Individual Impact and Organizational Impact as measures of overall Impact. Note, however, in Figure 2, consistent with DeLone and McLean (1992), the addition of Satisfaction as a further mediator between Quality and Impact.⁷

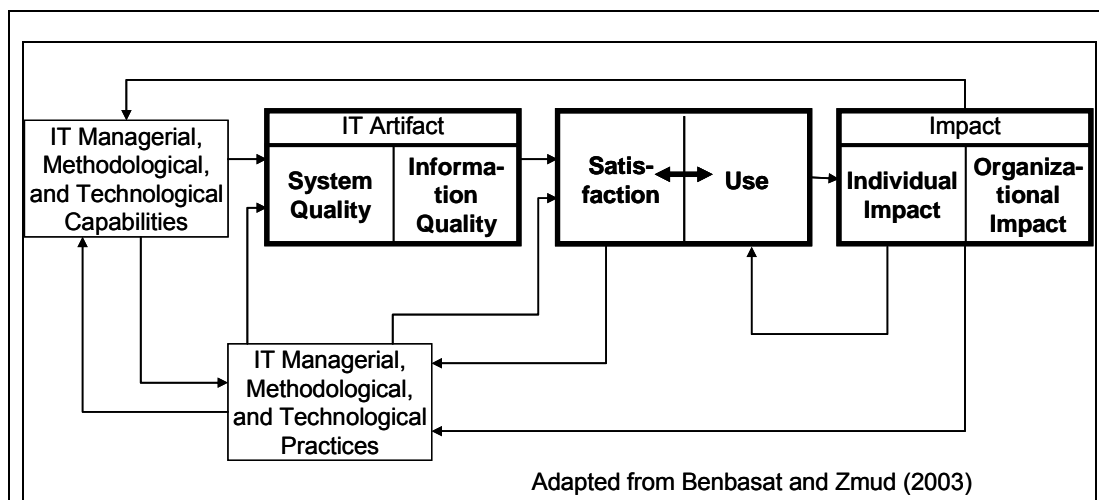


Figure 2. DeLone & McLean Mapped to the IS-Net

3.2. The Recursive Nature of IS Net (and DeLone & McLean)

As defined earlier, IS-Impact is a measure at a point in time - a snapshot of the system. Yet, the IS-Net in Figure 2 (consistent with DeLone and McLean (1992)) reflects the IT Artifact and Impact at different points in time; preceding and subsequent to Satisfaction and Use. To better reflect measures of Quality and Impact at the same point in time, in Figure 3 we expand and flatten the nomological net by eliminating feedback loops, thereby conveying the repeating nature of the IS-Impact pattern across time.⁸

⁷ This is not considered an oversight by Benbasat and Zmud, but rather a refinement here. Any of the constructs in Figure 2 could be expanded into a lower-level or alternative view.

⁸ Figure 3 also more clearly reflects Use as both antecedent and consequence of Impact.

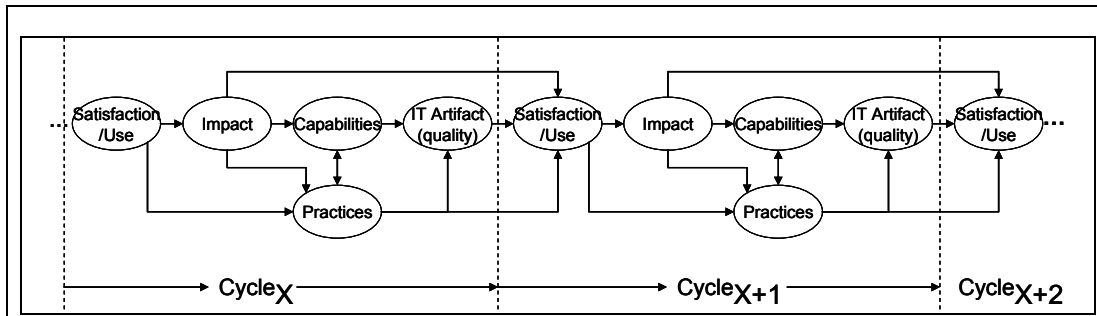


Figure 3. Flattening the Nomological Net (eliminating feedback loops)

As implied by DeLone and McLean (1992) and by feedback loops in the IS-Net, both of which are recursive (Figure 3), impacts resulting from the IS in one iteration will subsequently influence IT capabilities and practices, which in turn will influence the IS Quality and thereafter Satisfaction and Use, and so on.

3.3. Reconciling IS-Impact and IS-Net

In order to further isolate and associate Impact and Quality as measures of the IS, we next focus on any one of the cycles in Figure 3 and drag downward those concepts associated with the IT function⁹ – namely, Capabilities and Practices, thereby yielding Figure 4. Note that with the IS-Impact evaluation approach, Quality is measured at a point in time (What is the Quality of the system today?) at the end of a cycle in Figure 3. Impacts, however, are measured retrospectively, the question in essence being, “What have been the impacts to date?” Thus, while Impacts precede Capabilities and Practices in the causal flow of the IS-Net (as reflected in a cycle of Figures 1 and 2), they are measured retrospectively at the same point in time at which Quality is assessed (our focus being on “the system” as opposed to the IT function¹⁰). In combination, Impact and Quality represent a complete measure of the Information System (its flow of net benefits).¹¹

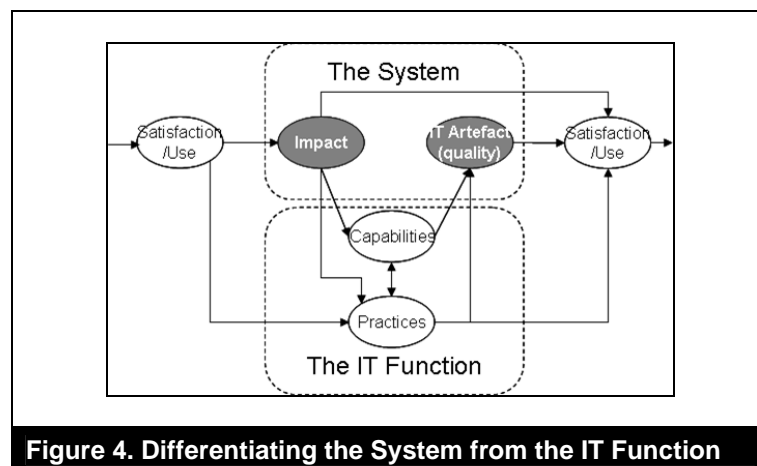


Figure 4. Differentiating the System from the IT Function

⁹ IT Function here ostensibly includes the central function, other IT capabilities and practices across the organization, and a possibly IT capabilities and practices outside the organization – e.g., the Outsourcer.

¹⁰ Note that the DeLone and McLean (2003) Service Quality construct may be the appropriate measure of the quality of the service provided by the IT Function.

¹¹ It is highlighted that IS-Impact is not simply an aggregate of four of the DeLone and McLean constructs. It is an aggregate of the Impact constructs from one cycle (n the DeLone and McLean model), and the Quality constructs from the subsequent cycle.

4. Research Design

To operationalize and validate the above model, the study employed a multi-method research design, extending the research cycle proposed by MacKenzie and House (1979) and McGrath (1979) for developing and validating a measurement model. It entailed two main phases and three surveys as shown in Figure 5: (1) an exploratory phase, to develop the hypothesized measurement model, and (2) a confirmatory phase, to test the hypothesized measurement model against new data gathered. Moreover, the exploratory phase of this study adheres to the two-step approach of Burton-Jones and Straub (2006) for operationalizing constructs and identifying measures. The aim is to adequately account for the context of large, contemporary IS (the Enterprise System) and to ensure model completeness and an appropriate choice of measures and dimensions.

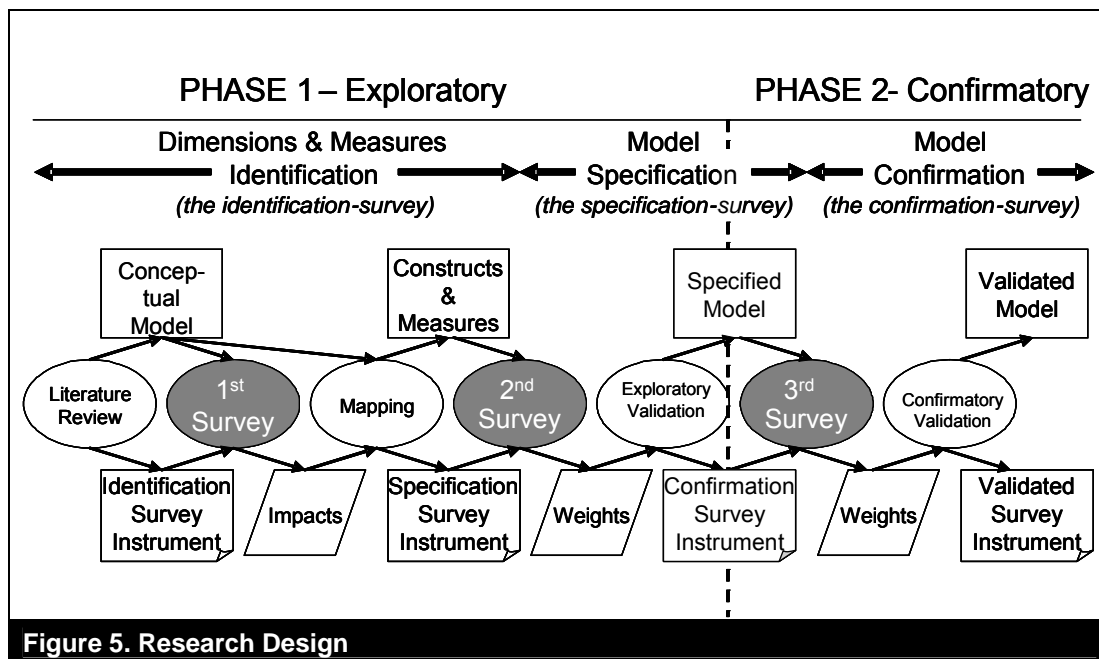


Figure 5. Research Design

The exploratory phase consists of two surveys; an identification survey followed by a specification survey. The identification survey is qualitative. Its purpose, akin to the function phase of the Burton-Jones et al. (2006) approach, is to identify the a-priori salient dimensions and measures for the Quality and Impact halves of the study conceptual model (Figure 1). While a common approach to identifying a-priori measures and dimensions is to select from the existing literature, based on conceptual arguments, we believe this is inadequate given study objectives and issues with past research. The identification survey, which canvasses stakeholders' perceptions of the impacts of a contemporary IS, yields qualitative data to substantiate existing measures and dimensions from the literature, thereby ensuring that (1) the referent measures and dimensions are not only conceptually, but also empirically relevant in the contemporary IS context, and (2) new measures or dimensions not already identified in the literature but possibly of significance in that environment are specified. The dimensions and measures substantiated and discovered in the identification survey phase subsequently became the basis of an a-priori model that was operationalized in the specification survey.¹² We conducted these two surveys across twenty-seven (27) public sector organizations (agencies) that had implemented SAP Financials in the late 1990s. This was an appropriate system and context, being relatively simple and homogenous: all Agencies were implementing the same ES; all agencies implemented around the same time and had been operational for approximately three years and, thus, were at a similar point in the ES lifecycle. What's more SAP Financials are the most homogenous application across the participating agencies (and across most organizations generally),

¹² Each measure has a corresponding perceptual question in the survey questionnaire.

even more so, given all are agencies of the same State Government. Further, Financials are intra-organizational systems, thus only internal stakeholders need be canvassed.

Next, employing validated measures from the specification survey, we conducted the confirmation survey at a large university that had implemented a different ES — ORACLE Financials. This survey served to validate the IS-Impact model and related instrument derived from the exploratory phase, reconfirming the model and measures using new data, thereby completing the research cycle as depicted in Figure 5. Table 2 summarizes the three surveys conducted.

Table 2: Details of the Three Surveys

Phase	Purpose	Organization	ES	Responses
Exploratory Phase				
Identification Survey	Identify the salient success dimensions and measures	27 Public Sector Agencies	SAP Financials	137
Specification Survey	Specify the a priori model using constructs and measures identified	27 Public Sector Agencies	SAP Financials	310
Confirmatory Phase				
Confirmation Survey	Validate the ES success model and instrument	Large University	Oracle Financials	153

5. The Identification survey

A good formative index is one that exhausts the entire domain of the construct completely, meaning that the items should collectively represent all the relevant aspects of the construct of interest (Bagozzi and Fornell, 1982, Bagozzi and Phillips, 1982, Fornell and Bookstein, 1982). In attention to content validity and earlier stated concerns that prior research has at times employed incomplete or inappropriate measures of success to gauge the overall IS-Impact, the main purpose of the initial, exploratory identification survey was to identify and substantiate a salient starting set of dimensions and measures from the perspectives of all key user groups. The identification survey inventoried impacts of SAP as perceived by staff across all levels of 27 government agencies in the state of Queensland, Australia¹³. The identification survey was non-anonymous, but confidential, with three main instrument sections querying (1) respondent demographics (e.g., name, position, years with agency, years with Queensland government) and a brief description of their involvement with the SAP system; (2) specific impacts of SAP; and (3) any past, in-progress, or pending initiatives for increasing positive impacts from SAP, as well as suggestions for further possible improvements.

The single, specific question posed in section (2) of the instrument was, "What do you consider have been the impacts¹⁴ of SAP in your agency since its implementation?"

5.1. Identification survey responses

The broadcast identification survey yielded 137 responses. Impact statements from section (2) of the instrument were diverse, including such things as the quality of reports, downtime of the system, cost reductions attained since the advent of the system, etc.

In order to specify dimensions and measures of Quality and Impact in the study model, we first (1) identify a referent set of relevant measures and model *dimensions*, before we (2) perform impact citation analysis — the mapping of impact citations from respondents into the referent measures to instantiate the measures and thereby substantiate the *dimensions* of the study model.

5.2. Identifying a Pool of Measures and Dimensions

Evaluation of candidate models and frameworks suggested the dimensions and measures of the

¹³ This was the first major implementation of SAP Financials in the public sector worldwide.

¹⁴ It should be highlighted that the word "impacts" in the identification survey was used in the broadest sense, to encompass impacts on individuals, the organization, information, the system, etc.

DeLone and McLean IS Success model as a starting set (DeLone and McLean, 1992, DeLone and McLean, 2002, DeLone and McLean, 2003, Myers et al., 1998).¹⁵ DeLone and McLean (1992) identified six constructs¹⁶ — System Quality, Information Quality, Organizational Impact, Individual Impact, Satisfaction, and Use — within which they summarized commonality they observed across prior measures of information system success.

It is noted that the System Quality and Information Quality constructs correspond logically with the Quality half of the study model in Figure 1; the Individual Impact and Organizational Impact constructs clearly correspond with the Impact half of that model. Though predisposed to the inclusion of only these four constructs as dimensions in the a-priori model, in attention to model completeness, all six DeLone and McLean constructs were considered in subsequent citation analysis, as described next.

5.3. Impact Citation Analysis

Prior to citation analysis, and consistent with formative index development procedures (Diamantopoulos and Winklhofer, 2001), we first analyzed the 119 measures identified from DeLone and McLean (1992) and Myers et al. (1998) for overlap and redundancy. We removed a total of 35 measures as a result (leaving 84). Eighteen of the 35 were believed to mirror a measure in another of the six dimensions (and were thus believed to be redundant for this study purposes)¹⁷; the other 17, mainly belonging to Organizational Impact, were removed due to their being overly financial or "non-perceptual"¹⁸ (and thus incongruent with the study objectives).

The impact statements from section (2) of the instrument were next decomposed into their component impact citations, ultimately yielding 485 citations (average of 3.5 citations per respondent). Decomposition of the text was straightforward, simply involving the extraction of contiguous phrases, without modification.

We then mapped the 485 citations into the remaining 84 measures by matching keywords extracted from each citation and measure. In order to minimize individual errors of judgment, two academics and two senior business analysts from surveyed organizations participated in the mapping exercise, each person mapping citations from approximately 20 respondents (approximately 70 citations each) and comparing results. Comparison of the individual classifications revealed an average inter-coder agreement of 80 percent¹⁹. Discrepancies were discussed until a consensus was reached and formal criteria for classification were documented.

Employing demographics collected (section 1 of the instrument), respondents were classified into three *key user groups* — Strategic-users, Operational-users, and Technical-users²⁰ — with 59, 57, and 21 respondents, respectively. Ideally, these key user groups would include representative response

¹⁵ We also considered the MIT 90s IT impacts framework (Allen and Scott Morton, 1994, Scott Morton 1991), the Balanced Scorecard (Kaplan and Norton, 1992), and the ERP benefits framework (Shang and Seddon, 2002). Ultimately, the MIT 90s framework and the Balanced Scorecard were dropped because they do not stipulate measures, but rather offer a methodology for identifying measures. Though an ES-specific classification of benefits, the Shang and Seddon framework was deemed unsuitable due to: perceived overlap among its measures and dimensions; its emphasis on a top management perspective (not a holistic view); and its focus on the organization rather than the system (e.g. no measures of the quality of the system).

¹⁶ DeLone and McLean in (2003) suggest Service Quality as a further measure of IS success. As the unit of analysis herein is the Information System (the ES), not the IT function, Service Quality was considered inappropriate.

¹⁷ The 18 measures included 1 Satisfaction, 3 System Quality, 8 Information Quality, 2 Organizational Impact and 4 Individual Impact measures.

¹⁸ The 17 measures include 1 System Quality, 2 Information Quality, 11 Organizational Impact and 3 Individual Impact measures.

¹⁹ Krippendorff recommends inter-coder reliability of at least 70% (Krippendorff, K. (1980) *Content Analysis: An Introduction To Its Methodology*. Beverly Hills, CA: Sage.)

²⁰ Technical-users being the "maintainers" of the system.

from the main groups of direct users of the IS – those users who access the system directly, or who use its direct outputs.²¹ Though these key user groups can vary with type of system (see discussion in Anthony (1965), Cameron and Whetten (1983), Seddon et al. (1999)), for IS that are largely intra-organizational (e.g., Financials) the cohorts are typically those identified (Sedera et al., 2006)

Table 3 summarizes impact citations for each of the six DeLone and McLean constructs, by key user group and in total. It is observed that 94 percent of the citations (456 out of 485) map readily into the 84 measures, with each measure, on average, cited 5.4 times. Twenty-nine citations (485 minus 456) did not map readily into any existing measure.

It is noted that the largest number of citations by Strategic users pertain to the Organizational Impact and Information Quality dimensions, the largest number by Operational users pertain to System Quality and Information Quality, and the largest number by Technical-users pertain to System Quality. This may suggest the relative closeness of these employment cohorts to the respective dimensions in their overall evaluation of IS-Impact.

Table 3: Mapping of Impact Citations

Dimension	Key User Group						Total			
	Strategic		Operational		Technical		Total		Measures	Citations/ Measure
	#	%	#	%	#	%	#	%	#	#
System Quality	44	19%	42	32%	53	54%	139	30%	14	9.9
Information Quality	60	26%	33	25%	10	10%	103	23%	15	6.9
Individual Impact	44	19%	27	21%	13	13%	84	18%	12	7.0
Organizational Impact	66	29%	10	8%	15	15%	91	20%	8	11.4
Satisfaction	12	5%	11	8%	4	4%	27	6%	6	4.5
Use	2	1%	7	5%	3	3%	12	3%	29	0.4
TOTAL	228	100%	130	100%	98	100%	456	100%	84	5.4

5.4. Deriving the a-priori model

Specifying a parsimonious a-priori model involved: (1) elimination and consolidation of measures; (2) introduction of new measures; and revisiting the relevance of the (3) Use; and (4) Satisfaction constructs.

Elimination and Consolidation of Measures: Subsequent to mapping, if a measure was not instantiated, it was removed. Where a citation readily mapped into multiple measures *within the same dimension* (thereby highlighting redundancy across the measures), with the goal of mutual exclusivity and parsimony, the most-suitable single measure was retained in the a-priori model. Where measures were noted to always occur in combination, in the interests of parsimony, those measures were combined into single measures.²²

Identifying New Measures: Where citations did not map into an existing measure, we created new

²¹ "Key users" does not include such groups as shareholders, debt holders or others who may indirectly have a vested interest in the impact of the IS, but who are not direct users of the system or its outputs (Note that such things as annual reports for shareholders and marketing material, are highly processed outside the IS and are distant from any IS that may have originated certain of their details).

²² Individual-Impact: six measures relating to decision making were consolidated into a single measure of decision making effectiveness; improved executive efficiency and task performance were combined into individual productivity; Organizational-Impact: three measures – product quality, service effectiveness and improved customer service, were combined in improved outcomes/outputs, and various citations of increased work volume became overall productivity. Information-Quality: measures of usefulness and completeness were combined as information relevance, it being reasoned that relevance subsumes usefulness and completeness (when information is not relevant, it is tautological that it is neither useful nor complete). Readability, clarity and appearance were combined into a single measure, reasoning that the information format implicitly reflects these qualities of the information.

measures and added then to the a-priori model, these new measures potentially representing features that have become more prominent with contemporary information systems. Existing measures of Organizational Impact, being largely quantitative-financial, did not adequately accommodate all cited impacts on the organization. While economic success is crucial for survival, an organization may be considered successful in many other ways (Davenport, 1998, Kaplan, 1998). It was decided that a more holistic Organizational Impact construct should include four new measures derived inductively (bottom-up) from the 29 unmapped citations: process improvement (seven citations), increased capacity (eight citations), e-government readiness (four citations)^{23 24} and cost reduction (five citations). The final five unmapped citations pertained to how customizable the system is, yielding a single System Quality measure – customizability.

It is noted that Use and Satisfaction had relatively few citations (3 percent and 6 percent respectively). On this basis, and in light of persistent concerns with their conceptualization, validity, and utility as IS Success constructs, they are next revisited.

The Use Construct: For a range of reasons, several authors have suggested that the Use construct is inappropriate to measure IS Success (Barki and Huff, 1985, Gelderman, 1998, Seddon, 1997, Yuthas and Young, 1998). It is noted that Use, though having the largest number of measures (29) in Table 3, is cited least (12), with only 0.4 citations per measure. We believe this is because Use is an antecedent (and consequence) of IS-Impact (as defined herein) rather than a dimension²⁵ (as reflected most clearly in Figure 4). On this basis, Use is not included as a dimension in the a-priori model (Burton-Jones and Gallivan, 2007).

The Satisfaction Construct: User satisfaction has been possibly the most extensively employed single measure for IS evaluation (DeLone and McLean, 1992, Doll and Torkzadeh, 1988, Etezadi-Amoli and Farhoomand, 1991, Gatian, 1994, Igbaria and Tan, 1997, Lucas, 1975). Several widely cited studies developed standard instruments that measure satisfaction (Bailey and Pearson, 1983, Baroudi and Orlikowski, 1988, Doll and Torkzadeh, 1988). Early satisfaction constructs in IS Success evaluation (e.g., user information satisfaction—Bailey and Pearson 1983) have been found to mix measures of multiple success constructs (e.g., quality and impact) rather than measure a distinct satisfaction construct (Gable 1996). Rai et al. (2002), state that user satisfaction has been measured indirectly through Information Quality, System Quality and other variables in prior studies. Additionally, Sedera and Tan, (2005) demonstrated – through content analysis of 192 satisfaction-related items from 16 Satisfaction instruments – that 98 percent (189) of the measures readily map into existing measures pertaining to System Quality, Information Quality, Individual Impact and Organizational Impact; with only two percent of the items (3 items) appearing to measure Satisfaction explicitly (See Table 4).

In light of past concerns and given these results, it is our view that Satisfaction is not a separate dimension of IS-Impact. This view is consistent with the findings of Teo and Wong (1998) who studied the impact of IT investment on organizational performance. Rather, when measured appropriately — consistent with DeLone and McLean (1992), and as reflected most clearly in Figure 4 — we believe Satisfaction is an immediate consequence of IS-Impact²⁶ (Anderson and Sullivan, 1993, Brady et al.,

²³ The instrument item on e-government has a direct analogue in the private sector e-business.

²⁴ No measures were added or removed due solely to the public sector context of the study. The relative emphasis of the model on intangibles is felt to fully account for public sector measures of success.

²⁵ DeLone and McLean (1992, p. 68) suggest that “usage, either perceived or actual, is only pertinent when such use is not mandatory.” When use of a system is mandatory, the extent of use of a system conveys little information about the impact of the system (Robey, 1979, Welke and Konsynski, 1980). While we believe the volitional or non-volitional nature of Use is an important consideration in the measurement of Use, this is not the reason for its exclusion from IS Impact. We note also growing interest in more complex understandings of Use, as reflected in such writings as Burton-Jones and Straub (2006) and Burton-Jones and Gallivan (2007).

²⁶ The conception of Satisfaction as immediate consequence of IS-Impact too has support in the marketing discipline. Services marketing researchers (e.g., Brady et al., 2005, Anderson and Sullivan, 1993, Spreng and Mackoy, 1996) employ a nomological net that positions Satisfaction as an immediate consequence of Service Quality; Satisfaction being antecedent of Behavioural Intention. Service quality, in the broader sense (as

2005, Grönroos, 1982, Grönroos, 2000, Spreng and Mackoy, 1996).

Table 4: Commonly Used Satisfaction Items and their Overlap with Other Constructs

#	User Satisfaction Instruments	No of Measures	II		OI		IQ		SQ		Total Overlap	
			#	%	#	%	#	%	#	%	#	%
1	Gallagher (1974)	15	0	0%	2	13%	12	80%	1	7%	15	100%
2	Bailey and Pearson (1983)	18	0	0%	0	0%	9	50%	9	50%	18	100%
3	Ives, Olson, Baroudi (1983)	9	0	0%	1	11%	5	56%	3	33%	9	100%
4	Sanders (1984)	9	7	78%	0	0%	2	22%	0	0%	9	100%
5	Raymond (1985)	10	0	0%	0	0%	6	67%	3	30%	9	90%
6	Franz & Robey (1986)	6	1	20%	0	0%	3	50%	2	33%	6	100%
7	Joshi, Bostrom, Perkins (1986)	14	0	0%	1	8%	7	54%	6	43%	14	100%
8	Baroudi and Orlikowski (1988)	5	0	0%	0	0%	5	100%	0	0%	5	100%
9	Doll and Torkzadah (1988)	12	0	0%	0	0%	6	50%	6	50%	12	100%
10	Chin, Deihl and Norman (1988)	5	0	0%	0	0%	1	20%	4	80%	5	100%
11	Davies (1989)	10	5	50%	0	0%	0	0%	5	50%	10	100%
12	Goodhue (1995)	14	0	0%	1	7%	4	29%	9	64%	14	100%
13	Amoli and Farhoomand (1996)	26	1	4%	1	4%	4	15%	20	77%	26	100%
14	Xiao and Dasgupta (2002)	13	0	0%	0	0%	6	46%	6	46%	12	92%
15	Somer, Nelson and Karimi (2003)	12	0	0%	0	0%	6	50%	6	50%	12	100%
16	Ong and Lai (2004)	14	0	0%	0	0%	5	36%	8	57%	13	93%
Total/Average Scores		192	14	7%	6	3%	81	42%	88	46%	189	98%

Note: II=Individual Impact, OI=Organizational Impact, IQ=Information Quality, SQ= System Quality

On the basis that: (1) prior Satisfaction items do not differentiate a unique dimension, (2) those unique Satisfaction items account for only four percent of impact citations, and (3) there is support in the literature for conceptualising Satisfaction as an immediate consequence of IS-Impact, Satisfaction was not included as a dimension in the IS-Impact a-priori model.

5.5. The A-priori Model

Figure 6 depicts the a-priori IS-Impact measurement model, including measures identified from the identification survey and related data analysis. It is noted that these data and analyses support our conceptualization of the model as consisting of two halves — the Impact half represented by the Individual Impact and Organizational Impact dimensions, and the Quality half represented by the System Quality and Information Quality dimensions, where ...

- Individual Impact is a measure of the extent to which (the IS) has influenced the capabilities and effectiveness, on behalf of the organization, of key-users.
- Organizational Impact is a measure of the extent to which (the IS) has promoted improvement in organizational results and capabilities.
- Information Quality is a measure of the quality of (the IS) outputs: namely, the quality of the information the system produces in reports and on-screen.

opposed to the narrower emphasis of DeLone and McLean (2003) on the IT function), is in many ways analogous with IS Impact. In example, Gronroos (1982, 2000), as cited in Brady and Cronin (2001, p.35), suggest two main service quality dimensions where "Functional quality represents how the service is delivered; that is, it defines customers' perceptions of the interactions that take place during service delivery. Technical quality reflects the outcome of the service act, or what the customer receives in the service encounter." With the "operational" IS (the focus of IS Impact), where the system itself is conceived as a stream of services or a systematized (automated) service, the system (and its quality) are the "functional" and its impacts are the "technical" (or outputs).

- System Quality is a measure of the performance of (the IS) from a technical and design perspective.

The model does not purport (is not concerned with) any causality among the dimensions; rather, akin to analytic theory²⁷ (Gregor, 2006), the constructs are posited to be formative dimensions of the multidimensional concept—IS-Impact wherein the dimensions have a causal relationship with the overarching measure – IS-Impact. The IS-Impact model adopts constructs represented by DeLone and McLean as causally or process related, but employs them for a different purpose. Impacts (Individual Impact and Organizational Impact) are explicitly and intentionally evaluated at the same time as Quality (System Quality and Information Quality) —retrospectively, up to a point in time and not mediated by Satisfaction or Use (see Figures 3 and 4). Though this snapshot or cross-sectional approach is often criticized where the intent of research is to test causality (due to it not technically testing for temporality²⁸), with the IS-Impact model a snapshot of the system is precisely what is sought.

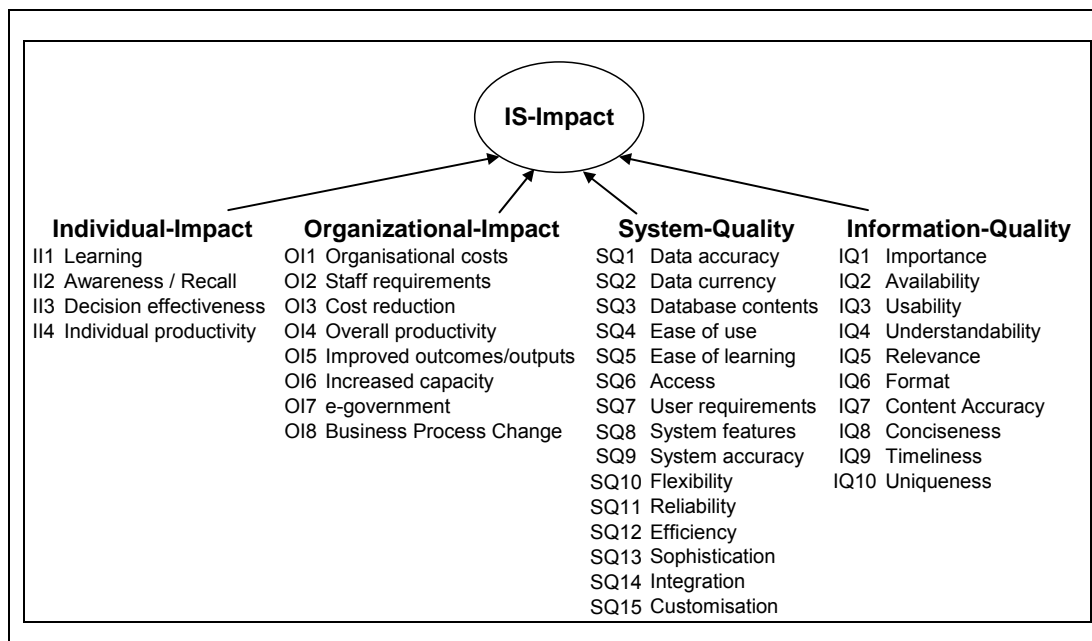


Figure 6. A Priori Model

6. The Specification survey

The purposes of the specification survey (the 2nd survey) were to further test and specify the a-priori model based on dimensions and measures derived from the identification survey. A survey instrument was designed to operationalize the 37 measures of the four constructs in Figure 6. The wording of each item was carefully designed to insure all items were answerable by all respondent cohorts.²⁹ We pilot tested the draft survey instrument (see Section 6.1) with a selected sample of staff of the State Government Treasury Department. The instrument instructed respondents, “Your answers should relate to your own experiences and perceptions of the SAP system in your agency.” The same 27

²⁷ The first of Gregor’s (2006) five types of theory in IS, analytic theories, “analyse ‘what is’ as opposed to explaining causality or attempting predictive generalizations ... they describe or classify specific dimensions or characteristics of individuals, groups, situations or events by summarizing the commonalities found in discrete observations” (2006, p.612).

²⁸ One variable should empirically precede the other in temporal order.

²⁹ Fully anticipating that any given respondent cohort may generally feel more comfortable and better informed to address certain of the items (e.g. the Strategic cohort on Organizational Impact).

public sector organizations from the identification survey were again surveyed. Three-hundred and nineteen responses were received, and nine responses excluded due to missing data or perceived frivolity, yielding 310 valid responses (35 Strategic users, 230 Operational users, 45 Technical users).

6.1. Content Validity

Close attention to content validity through analysis of Identification survey data, yielded items (Figure 6) that appear logical and consistent with prior research. As a further test of this association of items with constructs and their completeness, we followed the guidelines of McKenzie et al. (1999) for establishing content validity, which entailed four steps³⁰: 1) using the guidelines of Lynn (1986), created an initial draft of the survey instrument through canvassing the wealth of literature available in the IS Success domain; 2) following the guidelines of the American Educational Research Association (2002), established a panel of reviewers to evaluate the survey instrument, where a panel of six individuals were selected from academia and practice who possess relevant training, experience, and qualifications; 3) had the panel ('jury') critique the survey instrument — both the Identification survey and Specification survey instruments were pilot-tested by a sample of Treasury Department staff; and 4) had the jury conduct a review of the questionnaire, assessing how well each item represented the corresponding dimension. In this fourth step, a quantitative assessment was made, establishing the Content Validity Ratio (CVR) for each item/question based on the formula of Lawshe (1975). Based on eight pilot tests, the minimum CVR value of .75 was observed at statistical significance of $P < .05$. Feedback from the pilot round respondents resulted in minor modifications to wording of survey items (Lawshe, 1975, Lynn, 1986, McKenzie et al., 1999), and endorsement of the model and instrument completeness and association of items with dimensions (as in Figure 6).

Using the specification survey data, we next tested the a-priori model and related instrument items for validity. A key distinction of this report from previous writings by the authors on this study (Gable et al., 2003, Sedera and Gable, 2004), is the explicit treatment in data analysis of the model dimensions and the higher-order IS-Impact construct as formative.³¹

6.2. Formative Construct Validation

The pool of 37 measures distilled from the Identification survey serves as the starting point for the construction of a formative index for the latent construct under investigation. Following the guidelines of Diamantopoulos and Siguaw (2006) and Diamantopoulos and Winklhofer (2001), we first test for multi-collinearity among the measures. Formative measurement models are essentially based in regression (of the formative construct against its measures). This means that the stability of the coefficients of the measures can be affected by the strength of the measure intercorrelations (and sample size). Thus, excessive collinearity among measures makes it difficult to separate the distinct influence (and hence the validity) of the individual measures on the formative construct (Bollen, 1989). In addition, if a measure is a linear (or near-linear) combination of other measures, it would suggest that the indicator is redundant (in the context of the formative construct) and should therefore, in the interests of parsimony, be excluded from the construct.³²

³⁰ The four-step approach followed here is analogous to the Q-sort approach suggested by Kendall, J. E. and K. E. Kendall (1993) "Metaphors and methodologies: Living beyond the systems machine," *MIS Quarterly* (17) 2, pp. 149-171.

Kendall, K. E., J. R. Buffington, and J. E. Kendall (1987) "The relationship of organizational subcultures to DSS user satisfaction," *Human Systems Management* (7) 1, pp. 31-39

Tractinsky, N. and S. L. Jarvenpaa (1995) "Information systems design decisions in a global versus domestic context," *MIS Quarterly* (19) 4, pp. 507-534. for attaining content validity.

³¹ It is noteworthy that Petter et al. (2007) cite no examples of the proper specification of either the Individual Impact or Organizational Impact constructs (recognising that their list is not intended to be comprehensive); cited examples of the proper specification of other of the DeLone and McLean constructs are few, particularly in light of their extensive employment in IS research (e.g., only one example each of System Quality and Information Quality, both from the same study (Wixom and Todd, 2005) and both reflective.

³² We acknowledge that some (e.g. Bollen and Lenox (1991) as cited in Petter et al. (2007)) suggest retaining non-significant indicators in attention to completeness and content validity.

We thus first determined the Variance Inflation Factors (VIF³³) for the 37 measures from the Identification survey to determine which measures should be excluded. All measures were below the common VIF threshold of 10, with the largest VIF for the study measures being 7.1 (Kleinbaum et al., 1998); thus, all items were subjected to further testing as described next.

Diamantopoulos and Winklhofer (2001) observe that the “very nature of formative measures renders an internal consistency perspective inappropriate for assessing the suitability of indicators.” Thus, as suggested by Diamantopoulos and Winklhofer (2001, p.272), we employ a global item that “summarizes the essence of the construct that the index purports to measure” and examine the extent to which the items associated with the index correlate with this global item. In attention to the validity of each model dimension, this analysis is appropriately done at the dimension level. For this purpose, in addition to the 37 items reflected in Figure 6, we included four criterion measures in a separate section of the survey instrument³⁴ as listed below pertaining to Individual Impact, Organizational Impact, System Quality and Information Quality respectively.

- Overall, the impact of SAP (Financials) on me has been positive.
- Overall, the impact of SAP (Financials) on the agency has been positive.
- Overall, the SAP (Financials) System Quality is satisfactory.
- Overall, the SAP (Financials) Information Quality is satisfactory.

Correlating the 37 items with their respective criterion measures (matched as per the a-priori model in Figure 6), all 27 correlation coefficients are significant at the 0.001 level.³⁵ In the interests of parsimony, the correlation coefficients were scanned for a logical break point. It was observed that 27 of the 37 have coefficients of 0.5 or larger, the next largest being 0.4. Cohen (1988) has suggested the following interpretations for correlations in psychological research: Small (–0.3 to –0.1 ...or... 0.1 to 0.3), Medium (–0.5 to –0.3 ...or... 0.3 to 0.5), Large (–1.0 to –0.5 ...or... 0.5 to 1.0). Large correlations are expected of formative indicators. On this basis and in the interests of parsimony, those 27 items with $r \geq 0.5$ were retained for further analysis.

Next, we further validate the indicators, taking into account their interrelationships (Hauser and Goldberger, 1971, Joreskog and Goldberger, 1975). This is done through a Multiple Indicator Multiple Causes (MIMIC) model, using the four criterion measures as reflective indicators of our IS-Impact construct (Diamantopoulos and Winklhofer 2001). The fit statistics for the MIMIC model using the 27 remaining items evidence good fit with the data (e.g., chi-square = 459.12, d.f. = 129, RMSEA = 0.014, GFI = .89, NNFI = 0.87, and CFI = 0.98). Using the heuristics of Bollen (1989) (who suggests a GFI cut-off of 0.85), the observed GFI of 0.89 evidences good model fit, suggesting no need of further pruning of items. Next evaluating the Absolute Fit Indicators, the observed standardised RMR value of 0.10 also represents good fit. Steiger (1990) suggests that values 0.10 or below indicate good fit with the data; values below 0.05 indicate very good fit, and values below 0.01 indicate outstanding fit (Hu and Bentler, 1995); they, however, note that outstanding fit is rarely achieved. The model SRMR score of .088 also evidences good fit. Medsker et al. (1994) introduced the notion of chi-square and degrees of freedom as an index, treating ratios between two and five as indicating good fit; with a ratio of 3.34, the 27 final measures display a reasonable fit with data. Next, looking at the comparative fit measures (less affected by sample size), the Normed Fit Index (NFI), Non Normed Fit Index (NNFI), Incremental Fit Index (IFI) and Comparative Fit Index (CFI) are all observed to demonstrate strong fit with the data (NFI = 0.97, NNFI = 0.87, IFI = 0.98, and CFI = 0.98).

Finally, we assess the formative variables, focusing on the nomological aspects, by linking the index to other constructs with which it would be expected to be linked. According to Jarvis et al. (2003),

³³ While most authors use a VIF cut-off of 10, some alternatively report Tolerance scores, Tolerance simply being the reciprocal of VIF.

³⁴ The four criterion measures for the four dimensions were included at the end of the instrument, separate from the 37 items, in attention to possible common method variance.

³⁵ Though CMV is less of a concern with formative constructs given that items need not co-vary, several items were intentionally negatively worded (reverse-coded) in order to detect response pattern bias. It is noted that all reverse-coded items appropriately correlate negatively with the criterion items.

these other constructs can be either antecedents or consequences of the phenomena under investigation. Bagozzi (1994) suggests, "After all, the substantive reason behind index construction is likely to be how the index functions as a predictor or predicted variable" (p. 332).

Thus, consistent with Jarvis et al. (2003) and Bagozzi (1994), and with the (third) guideline of Diamantopoulos and Winklhofer (2001) for validating formative constructs in a nomological network, we next test the relationship between IS-Impact and its immediate consequence: Satisfaction (see earlier discussion on Satisfaction). A single item reflective Satisfaction measure was gathered in a separate section (toward the end) of the same survey instrument: "Overall, SAP (Financials) is Satisfactory." The hypothesis is that a higher level of IS-Impact yields a higher level of Satisfaction. Model estimation revealed a path between IS-Impact and Satisfaction with $\beta=0.854$ and $p<.001$, thereby supporting our hypothesis and further evidencing the validity of the IS-Impact index and its 27 measures.

6.3. Respondent Cohorts

Anecdotal evidence (and common sense) suggests that each key user group tends to be better informed about and relatively more influenced by certain of the IS-Impact dimension(s). Identification survey results support this. To further test this notion, and in further attention to the validity of the dimensions and cohorts, we correlated individual dimension scores (the average of those items associated with each dimension as in Figure 6) with the Criterion-Average (the average of the four criterion items) separately for each of the three key user groups, yielding Table 5. It is observed that of the three key user groups, (i) Technical users and Operational users correlate most strongly with System Quality, and (ii) Strategic users and Operational users with the other three dimensions.

Table 5: Correlation between Dimensions & Criterion by Key User Groups

		Criterion Average		
	No	35	230	45
	Dimension	Strategic	Operational	Technical
(i)	System Quality	0.74	0.84	0.83
(ii)	Organizational Impact	0.78	0.76	0.59
(iii)	Individual Impact	0.76	0.76	0.44
(iv)	Information Quality	0.73	0.73	0.68

This appears sensible. Operational users have direct experience of the Information System and its System Quality, as do Technical users who also receive feedback on System Quality from Operational users. Strategic-users are logically most concerned with Organizational Impact (followed by Operational users). The efficiency and effectiveness of Operational-users (Individual Impact) and Strategic users are expected to be more affected by the system than these of Technical-users. These findings, consistent with expectations, further evidence the validity of the dimensions and of the key user groups.³⁶ The variation of correlations observed in Table 5 across the key user groups suggests logical, important and differing perspectives, reinforcing the need to account for all of these perspectives in arriving at a holistic view of the Information System. In further evidence of this argument, it is noted that T-tests of the Criterion-Average across the key user groups, identified significant ($p<.01$) differences between each cohort pair.

6.4. Additivity

The additivity of the model measures and dimensions has been evidenced indirectly by the strong path observed between overall IS-Impact and Satisfaction when identifying IS-Impact through structural relations. As a more direct test of additivity, we next averaged the items associated with each dimension to yield four independent variables (similar to the prior section on cohort validity but here for the full sample) and employed the average of the four criterion measures as the dependent

³⁶ Thus in evidence of "concurrent" criterion validity, we note our ability with the dimension scores, to logically discriminate between the cohorts.

variable in regression. Results demonstrate that each independent variable makes a significant incremental contribution to r^2 .

To conclude this discussion on the Exploratory phase, Table 6 is a summary of measures considered, dropped and retained at various stages across the research cycle. Appendix B details the final 27 items.³⁷

Table 6: Summary of Measures Considered, Dropped and Added across Study Stages

Research Stage	Literature Review			Identification Survey			Specification Survey		Confirmation Survey	
Analytic Approach	Literature Review			Citation Analysis & Mapping			Exploratory Factor Analysis		Confirmatory Factor Analysis	
Dimension	Start	Drop	Remain	Drop	Add	Remain	Drop	Remain	Start	Remain
Systems Quality	18	4	14	0	1	15	6	9	9	9
Information Quality	25	10	15	5	0	10	4	6	6	6
Individual Impact	19	7	12	8	0	4	0	4	4	4
Organizational Impact	21	13	8	4	4	8	0	8	8	8
Satisfaction	7	1	6	6	0	0	0	0	0	0
Use	29	0	29	29	0	0	0	0	0	0
Total	119	35	84	52	5	37	10	27	27	27

7. The Confirmation survey

Though the specification survey derived a formative index for IS-Impact that was validated using rigorous statistical tests, it is imperative that this index be cross-validated on new data (See Cudeck and Browne (1983)). The confirmation survey further extends the credibility of the IS-Impact index by subjecting it to further validation with new data.

The confirmation survey was conducted in a large university that had in the late 1990s implemented a different Enterprise System — ORACLE Financials. The reduced set of IS-Impact items³⁸ was employed (see Appendix B), with two simple modifications: (1) the name of the ES software package was changed from SAP to ORACLE, and (2) 'Agency' was replaced with OAU (Organizational Administration Unit, which is a commonly used term within the university). This time all survey instruments were hand-delivered and anonymously returned. In addition to the IS-Impact items, respondents were requested to provide details of (1) general demographics, (2) the OAU, and (3) prior experience with the Oracle Financials. We distributed the instrument to all 185 registered ORACLE users, and received a total of 153 valid responses, yielding a response rate of 83percent (Anderson and Gerbing, 1982, Bearden et al., 1982, Bentler and Chou, 1987, Boosma, 1982).

As with the Specification survey data, VIF tests on the confirmation survey data again supported retention of all model items. Testing the MIMIC model revealed chi-square = 459.75, d.f. = 98, GFI = .86, NFI = 0.97, RMSEA = 0.2, and CFI = 0.97, suggesting a good fit with the data.

8. Conclusion

The final IS-Impact Model (Figure 7) includes four dimensions in two halves. While the IS-Impact model adopts constructs represented by DeLone and McLean as causally or process related, it employs them for a different purpose. Impacts (Individual Impact and Organizational Impact) are explicitly and intentionally measured at the same time as Quality (System Quality and Information Quality) — retrospectively, up to a point in time, and not mediated by Use (as reflected in a cycle of Figure 3). Though this snapshot or cross-sectional approach is often criticized when the intent of

³⁷ Items in Appendix B are stated in a general format applicable to both the Specification-survey and the later Confirmation-survey. The 10 items dropped are boxed in Appendix B.

³⁸ At the behest of university financial management, the item "(the IS) has resulted in better positioning for e-Government/Business" was excluded, as the Financial system was not perceived to offer any e-Business services.

research is to test causality (due to it not technically testing for temporality), with the IS-Impact model a snapshot of the system is precisely what is sought.

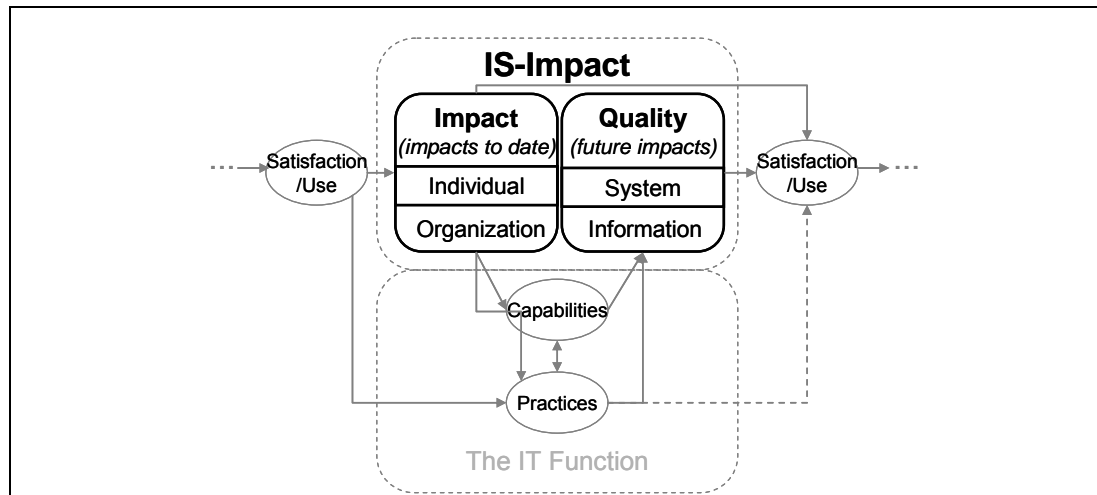


Figure 7. The IS Measurement Model

Thus, we suggest that the validated constructs and measures of the IS-Impact model can be used in combination as dimensions of a measurement model for the purpose of evaluating overall IS-Impact. Alternatively, these same constructs and their related, validated measures may be used in a nomological net to test causality; in so doing however, close attention must be paid to the timing of measurement and the consequent direction of the paths.³⁹ We see here an interesting example of how the same constructs can be used for differing purposes. It is further noted that the validation of these constructs, either within a nomological net or a predictive chain or within a measurement model, lends credence to the constructs for either purpose.⁴⁰

This paper has stringently treated the model and its dimensions as formative. The authors have from the outset and throughout the study consistently conceived of both the model dimensions and the sub-constructs as formative, manifested in extensive attention to the completeness, mutual exclusivity, and necessity of dimensions and measures. In order to insure measurement model specification and validation proceeded from an inclusive view on IS-Impact, primary evidence collection commenced with the Identification survey (yielding 485 qualitative impact citations), and the full set of 119 measures of IS Success as reported by DeLone and McLean (1992) and Myers et al. (1998).

In the interests of accuracy and parsimony, all measures and dimensions should be necessary. This means there should be minimal redundancy or overlap (mutual exclusivity), but also there should be no unnecessary dimensions or measures. Conceptual arguments that drew on past research, combined with impact-citation analysis, suggested the sufficiency of the four IS-Impact dimensions. Review of the literature and critique of the starting 119 measures identified redundancy, yielding a reduced set of 84 measures. Qualitative citation analysis and mapping further reduced these to 37 measures. Though VIF scores suggested minimal danger of multicollinearity, in the interests of parsimony, criterion correlation analysis of Specification survey data resulted in further pruning of the items to 27. These 27 (less 1 – see footnote 38) were again supported by Confirmation survey data and analysis; with each of these final measures explaining unique variance in IS-Impact.

³⁹ Where a cross-sectional survey measures both impact and quality, impact may precede rather than follow quality in the causal chain, as in Figure 7.

⁴⁰ Having said this, we further encourage researchers to heed Burton-Jones and Straub (2006), who caution that operationalization must be undertaken in full light of the specific theory and hypotheses being tested.

Though we have consistently viewed the model and its dimensions as formative, we have in predecessor work validated these as reflective (i.e., Gable et al., 2003; Sedera and Gable 2004), because of concern with the necessary analytic techniques and related anticipated problems with journal acceptance of the arguments. We have been pleased to note that recent work in the IS literature (i.e., Petter et al., 2007) has, to some extent, paved the way; this and encouragement from this journal's editor motivated us to revisit the data herein employing the formative construct validation tests reported. A further reason for our prior treatment of the model as reflective was our expectation that the items and dimensions, though formative, would in reality co-vary substantially.⁴¹ For example, conceptually we anticipated that a high quality system would be of high quality along all or most of its dimensions and measures and that a poor quality system would be of poor quality along all or most of its dimensions and measures (perhaps due to a common cause, e.g., – excellent IT management or an excellent development/implementation team). At the dimension level, while it is possible for a system to have high System Quality and low Information Quality, this is not likely, particularly with well-established packaged software solutions.

Following are discussed implications for research, implications for practice, study limitations, and related follow on research.

8.1. Implications for Research

The IS-Impact study, model and approach address several areas of uncertainty with past IS Success research, as follows (relevant stages of the study indicated in parentheses). The study: (1) In attention to proliferation of overlapping measures, comprehensively evaluated extant items, resolving redundancy and identifying new measures for contemporary IS (literature review, impact citation analysis, formative tests); (2) Presented a possible reconciliation of persistent confusion regarding the role of the DeLone and McLean constructs as measures versus explanandum, conceptually demonstrating their value as both (model conceptualization); (3) Represented the first test of the sufficiency and necessity (or not) of the six DeLone and McLean constructs (impact citation analysis, satisfaction content analysis, formative tests, incremental contribution to r^2); (4) Ultimately, evidenced the sufficiency and necessity of the four IS-Impact dimensions (impact citation analysis, formative tests, incremental contribution to r^2 , cohort correlation analysis); (5) Consistent with contemporary views in Information Systems and other disciplines, presented a strong rationale for conceiving satisfaction as a consequence of success rather than a dimension (model conceptualization, satisfaction content analysis, model identification through structural relations). The study makes a further contribution to knowledge by, consistent with past conceptual argument (e.g., Anthony, 1965), empirically evidencing (6) the existence of three main, relevant respondent cohorts (or key user groups) in the study context, (impact citation analysis and cohort correlation analysis).

To the extent that the IS-Impact model is robust across systems, contexts, and time, IS-Impact may serve as a validated dependent variable in ongoing research into the drivers of IS-Impact. As an independent variable, IS-Impact may aid in understanding the relationship between IT and organizational performance. Across systems in an organization, IS-Impact may yield a measure of performance of the applications portfolio. With further research, IS-Impact may ultimately yield valuable cross-organizational comparisons of IT performance between application areas, system sourcing scenarios, sectors, geography, cultures, organization size, and other demographic groupings.

8.2. Implications for Practice

The IS-Impact model, dimensions, and measures are designed to be robust, economical, and simple, yielding results from multiple user perspectives that are comparable across diverse systems and contexts. While the overall IS-Impact score and the four individual dimension scores have value, the model halves also can have meaning for practitioners. Lo-Quality/Lo-Impact is cause for serious concern, and probably a major re-think of the system. Lo-Impact/Hi-Quality suggests potential for

⁴¹ See Appendix C for brief discussion on the potential for co-variation among formative constructs.

harvesting substantial benefits, and a need to insure that advantage is gained from the quality achieved. Hi-Impact/Lo-Quality⁴² may have been strategic in the short-term (or not), but investment must now be made in raising the System Quality if future gains are to be realized; Hi-Quality/Hi-Impact is the ultimate goal.⁴³

Segmenting the sample on the basis of various demographics or other distinctions observed in the data can facilitate potentially useful comparisons. As a rule, highly consistent scores indicate some level of consensus (e.g., across the full sample, within stakeholder groups, or within organizational entities). Inconsistent scoring may point to areas of difference within these groupings, warranting attention.⁴⁴ Dependent upon organization size and number of respondents, useful comparisons may be possible across stakeholder groups, or across organizational units – e.g., by (1) application size (#seats, #named-licenses, license fees), (2) organizational unit size (#employees, turnover, assets), (3) type (service, production, support). It is also possible to repeat the study for other systems or modules, or at a later date, in order to compare across systems and across time (for the same system).⁴⁵

Thus the IS-Impact approach may be of interest to organizations seeking to: (1) Evaluate the goodness of contemporary IS using an easy-to-understand, perceptual survey instrument; (2) Assess the level of IS-Impact from multiple stakeholder perspectives (e.g., Strategic users, Operational users, and Technical users); (3) Measure IS-Impact using tangible as well as less tangible indicators; (4) Identify and understand trends in system performance over time; (5) Establish an IS-Impact benchmark for comparison across versions/upgrades, organizations, departments, system types, system modules or across other demographic groupings; (6) Further justify the IS subsequent to implementation; and (7) Focus scarce resources and attention on those aspects of the IS and the organization most in need.

8.3. Limitations and Follow on Research

Despite having extended the rigorous approach adopted from MacKenzie and House (1979), and despite validity demonstrated, we recognize several limitations of the IS-Impact model requiring attention beyond the scope of this study and paper. First, the model was developed and validated with data only from the Australian public sector. This raises questions about whether the initial list of impact citations used in the development of the a-priori model was complete and representative of contemporary IS in general, and whether the final list of measures and dimensions are, indeed, generalizable. Related follow on research in the private sector that repeats the *entire* research cycle described herein is in progress to address this. Second, while we have argued both conceptually and through the impact citation analysis the inappropriateness of the traditional Use construct as a dimension, given the four dimensions of the IS-Impact model, this redundancy has not been demonstrated empirically. Longitudinal work evaluating Use as both antecedent and consequence of IS-Impact too is intended.⁴⁶

We note that formative construct validation suggested the exclusion of 10 of the 37 items following

⁴² It is recognized that the halves will usually coincide (e.g. Hi with Hi). And while Hi-Impact/Lo-Quality is perhaps the least likely combination, it is possible, e.g., due to a “technology swap”, where the new system is customized to look like the old in hopes of containing costs and minimizing change.

⁴³ Is the IS yielding positive impacts? Should it be at this stage of the lifecycle? Is quality high? Are positive impacts being delivered? Are these scores consistent with expectations; with plans and forecasts? Are they consistent with other indicators? If not, why not?

⁴⁴ Are scores within stakeholder groups consistent? If not, do there seem to exist sub-groups? What defines these sub-groups?

⁴⁵ Do all stakeholder groups score the dimensions similarly? If not, why not? Were any meaningful sub-groups identified? How do their views differ? Are things getting better or worse? Is the system working well in parts of the organization, and not in others?

⁴⁶ It is noted that Strategic users who may merely use the output of the system and not the system itself, would qualify as volitional users, their use being an interesting variable to consider in future validations of the model (our thanks to an anonymous reviewer for this suggestion).

the Identification survey. Though this has resulted in a more parsimonious solution, which demonstrates face and content validity, we recognize value in the ongoing validation of the IS-Impact model with other applications, in which effort we encourage consideration of the possible relevance of the full pool of 37 items (Appendix B).

In conclusion, an extensively validated and widely-adopted IS-Impact model would facilitate cumulative research on IT impact, while providing a benchmark for organizations to track their IT performance. These study results offer a significant step in this direction.

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Appendix A – The Benbasat & Zmud IS Nomological Net

Benbasat and Zmud (2003) introduced the IS-Net (Figure A.1) in an attempt to prescribe an identity for the field of IS by conscribing a core set of high-level concepts: (1) IT Artifact, (2) Impact, (3) Use, (4) Capabilities and (5) Practices. They argue that, in addition to studying the IT Artifact, one should focus on how IT Artifacts are conceived, how they are being used, supported and evolved, and how IT Artifacts impact (and are impacted by) the context in which they are embedded.

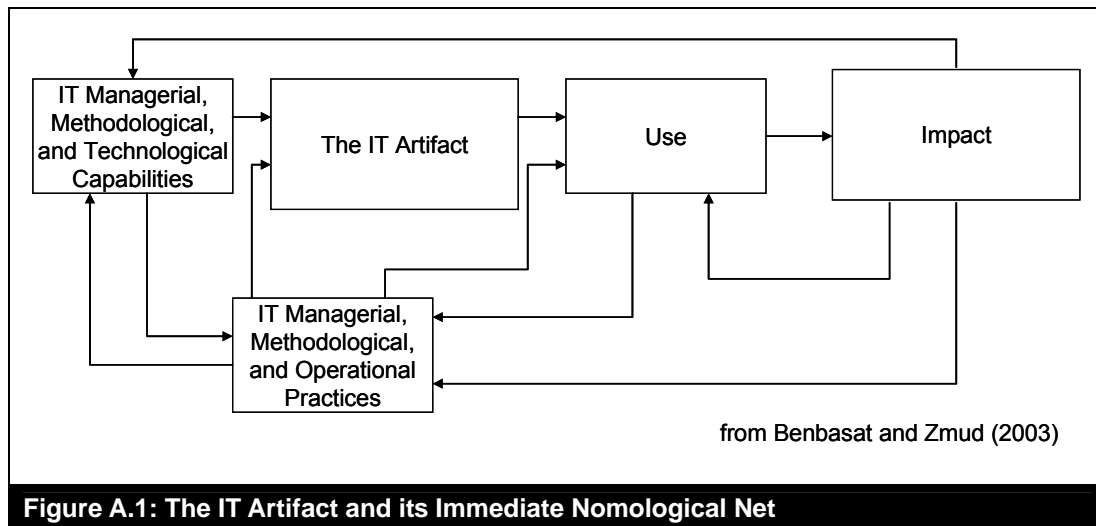


Figure A.1: The IT Artifact and its Immediate Nomological Net

The IS-Net has been the subject of much debate. In example, Agarwal and Lucas (2005) express concern that the IS-Net addresses only 'micro' level IS research issues, where 'micro research is generally viewed as being at the individual or group level of analysis.' They further espouse the importance of 'macro' research that focuses on organizations, environments and strategy (2005, p.391). They and many others also argue the importance and relevance of IS research that has individual or societal welfare at heart (rather than organizations), that too perhaps being beyond the scope of the IS-Net.

Agarwal and Lucas (2005, p.391-393) further state, "We believe that a major part, but not all, of the research on IS should focus on the impact of the IT artifact rather than the artifact itself (...) It is possible that Benbasat and Zmud agree with our call for more macro research given the inclusion of the impact variable in their nomological net". Thus, the distinction made by Agarwal and Lucas between micro- and macro-level research issues is unclear as regards organizational-level research, which would seem to bridge their micro- and macro-realms.

We agree with this latter comment by Agarwal and Lucas, that in addition to micro-level IS research (as they define it), the IS-Net also pertains to organization-level research. Discussion on IS-Impact herein, both preceding and following, has assumed a decidedly organization-centric perspective (even at the Individual level, the impact of a system is measured to evaluate system-related benefits for the organization e.g., individual productivity and effectiveness 'in the job'). Though Agarwal and Lucas and others consider the IS-Net overly constrained, they too appear to believe it valid within its scope (note that the possible inclusion of external stakeholders (e.g., inter-organizational systems) does not change the organization-centric view or the unit of analysis (the system). If the focus is society or individuals rather than the organization, concern shifts to the welfare of individuals or society, requiring quite different impact measures).

Appendix B – The Pool of 37 IS-Impact Measures (a-priori model)

Category A: Individual-Impact is concerned with how (the IS) has influenced your individual capabilities and effectiveness on behalf of the organization.

1. I have learnt much through the presence of (the IS).
2. (the IS) enhances my awareness and recall of job related information
3. (the IS) enhances my effectiveness in the job
4. (the IS) increases my productivity

Category B: Organizational-Impact refers to impacts of (the IS) at the organizational level; namely improved organizational results and capabilities.

5. (the IS) is cost effective
6. (the IS) has resulted in reduced staff costs
7. (the IS) has resulted in cost reductions (e.g. inventory holding costs, administration expenses, etc.)
8. (the IS) has resulted in overall productivity improvement
9. (the IS) has resulted in improved outcomes or outputs
10. (the IS) has resulted in an increased capacity to manage a growing volume of activity (e.g. transactions, population growth, etc.)
11. (the IS) has resulted in improved business processes
12. (the IS) has resulted in better positioning for e-Government/Business.

Category C: Information-Quality is concerned with the quality of (the IS) outputs: namely, the quality of the information the system produces in reports and on-screen.

13. Information available from (the IS) is important
14. (the IS) provides output that seems to be exactly what is needed
15. Information needed from (the IS) is always available
16. Information from (the IS) is in a form that is readily usable
17. Information from (the IS) is easy to understand
18. Information from (the IS) appears readable, clear and well formatted
19. Though data from (the IS) may be accurate, outputs sometimes are not
20. Information from (the IS) is concise
21. Information from (the IS) is always timely
22. Information from (the IS) is unavailable elsewhere

Category D: System-Quality of the (the IS) is a multifaceted construct designed to capture how the system performs from a technical and design perspective.

23. Data from (the IS) often needs correction
24. Data from (the IS) is current enough
25. (the IS) is missing key data
26. (the IS) is easy to use
27. (the IS) is easy to learn
28. It is often difficult to get access to information that is in (the IS)
29. (the IS) meets (the Unit's) requirements
30. (the IS) includes necessary features and functions
31. (the IS) always does what it should
32. The (the IS) user interface can be easily adapted to one's personal approach
33. The (the IS) system is always up-and-running as necessary
34. The (the IS) system responds quickly enough
35. (the IS) requires only the minimum number of fields and screens to achieve a task
36. All data within (the IS) is fully integrated and consistent
37. (the IS) can be easily modified, corrected or improved.

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Appendix C – Co-variation among Formative Measures

Wilcox et al. (in press) discuss the difficulties of specifying a construct as strictly formative or reflective. On the question 'Do the relationships among the observables inform the decision?' and considering the possibility of co-variation among formative items, they state (Wilcox et al., in press, p.3) ...

"Jarvis et al. (2003) also claim that for formative measures, covariation among the indicators is not necessary or implied. Does this claim mean that formative indicators are not correlated? Does the claim mean that correlation is not relevant? Addressing the initial question first, the answer is no, the claim simply means that the source of the covariation does not (cannot) come from the latent variable being formatively measured. Thus, to the extent that formative observables are correlated, the correlation must come from somewhere else as depicted in (Figure C.1). The sources of covariation are numerous with some better known than others."

Cohen (1990) as cited in Wilcox et al. (in press, p. 3) observes that "one researcher's measurement model may be another's structural model". Wilcox et al. (in press, p.4) conclude that "Correlation among formative indicators, even high correlation, may be possible."

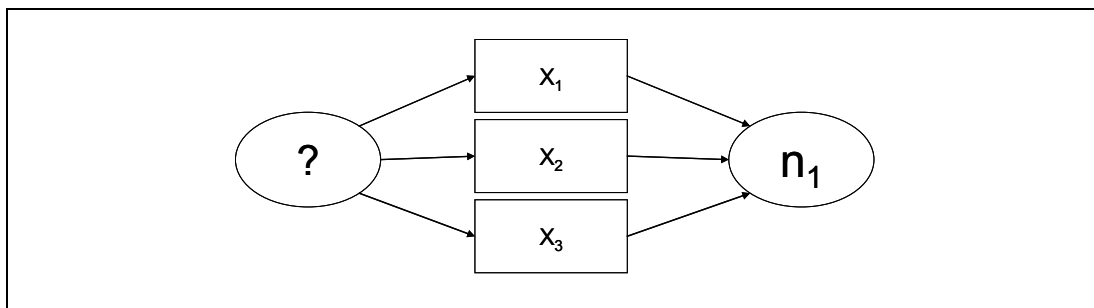


Figure C.1: Correlated Indicators in a Formative Model

(adapted from (Wilcox et al., in press, p.4)).

Wilcox et al. (in press) go on to further complicate the matter, suggesting that the same list of items might, depending on the wording of the general instructions, be conceptualized as either formative or reflective. In example, they depict (Figure C.2) items used by Gaski and Nevin (1985) to measure 'perceived coercive power' (actions a supplier might take to coerce), as both reflective and formative. They state (Wilcox et al., in press, p. 2) ...

"If the general instructions involve future actions, the responses might reflect a general capability by the supplier. Since the instructions refer to hypothetical actions the respondents are likely to reply based on some general notion of supplier capability instead of specific actions. Conversely, if the general instructions are pointing to past behavior a formative measurement model might be more applicable."

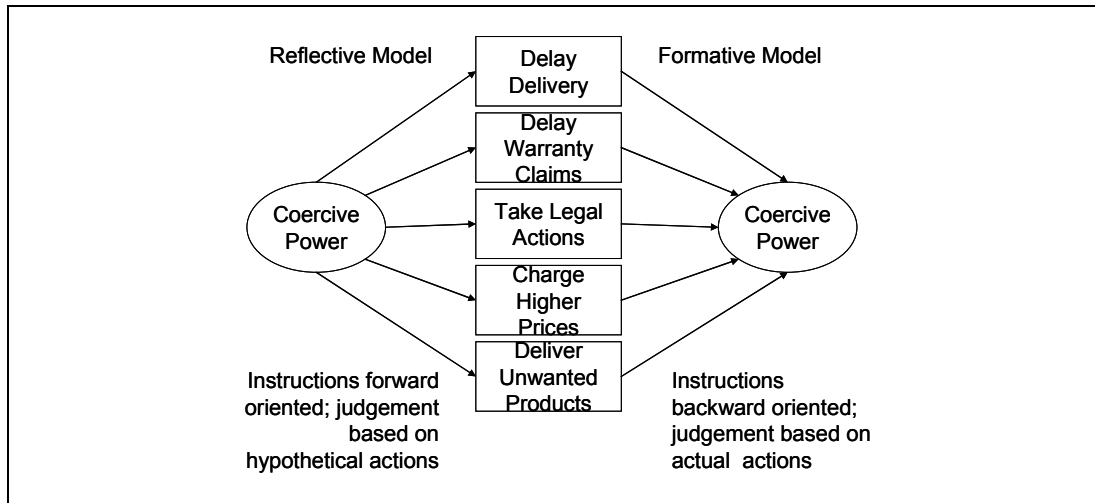


Figure C. 2: Different Measurement Conceptualizations Involving the Same Items

(adapted from Wilcox et al. (in press, p.2)).

Thus, we the authors suggest that perhaps one should consider the "formative" or "reflective" nature of the response rather than the formative or reflective nature of the measures. Regardless, attempts to further disentangle these various influences on respondent scores are beyond the scope of this paper.

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