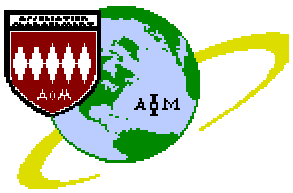

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EXTENDING THE GABLE ET AL. ENTERPRISE SYSTEMS SUCCESS MEASUREMENT MODEL: A PRELIMINARY STUDY

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ABSTRACT

Measuring the success of Enterprise Resource Planning (ERP) systems for adopting organizations is an emerging area of research. Our study complements the growing body of knowledge in this area as we attempt to extend the dimensions of success in the measurement model proposed by Gable and colleagues [20, 57, 60]. Overall, this study employed a three-phase approach to enhance its validity; however, in this paper we will focus on the findings from the major phase. In the study's main phase, we used postal surveys in Finland and Estonia (two small Northern European countries with businesses adopting ERP systems) to obtain empirical data from 62 subjects in 44 private firms in diverse industries. Our data analysis, using criterion validity and structural equation modeling approaches, suggests that the dimensions of Workgroup Impact and Vendor/Consultant which were added to the model proposed by Gable and colleagues are relevant, and capable of offering useful insights regarding ERP systems success evaluations. The implications of the study's results are discussed.

Keywords: Enterprise Systems, ERP, ERP Systems Success Measurement, Evaluation, Structural Equation Modeling, Criterion Validity, Firms, Northern Europe

INTRODUCTION

There are several types of enterprise systems; examples include Customer Relationship Management (CRM), Supply Chain Management (SCM) and Enterprise Resources Planning (ERP) systems [13, 14, 35, 41]. We focus attention solely on ERP systems because the previous research efforts by Gable et al. 2003 [20] and Sedera and Gable [60] that this paper draws from concentrated on this specific class of enterprise systems. An ERP is a complex business application designed to integrate business processes and functions, and it is capable of presenting a holistic view of a business by permitting the sharing of common data and practices in a real-time environment [3, 13, 14, 35, 41]. In this study, we focus our discussions on the software at a generic level by concentrating on its basic functionality rather than distinguishing between top-of-the-line and mid-market products. Empirical evidence exists suggesting that, in some respects, the benefits of ERP may be comparable even when systems' types differ [e.g., 29, 38, 39]. Moreover, ERP systems classified as top brands have been noted as not being totally similar as each might offer different capabilities [66]. The foregoing partly explains our choice of the technology in lieu of types.

Businesses worldwide are adopting ERP for a variety of reasons, including legacy systems replacement, cost reductions and faster information transactions, among others [13, 14, 24, 39, 71]. The top ERP vendors include SAP and Oracle [4, 39, 52]. ERP adoption continues to grow globally [2, 4, 39, 52, 71] despite the difficulties and risks encountered by organizations when they adopt and implement these systems [17, 41-43, 53, 67, 68]. It has also been reported that the ERP market worldwide is expected to grow from US$47.8 billion in 2004 to US$64.8 billion by 2009 [4] which gives an indication of the popularity of the technology.

Assessing the success of ERP in adopting organizations is difficult because of their complex nature [13, 14, 35, 41, 57]. Moreover, such systems are capable of generating a wide range of benefits (tangible and intangible) to different organizational users [66]. Further, some adopting organizations appear to have given up hope of evaluating the benefits or success of their ERP due to a lack of knowledge regarding such exercises [26]. In-depth interviews with seven (7) case companies in two Northern European countries (i.e., Estonia and Finland) regarding how they evaluate the success of their ERP revealed that only three (3) had any formal evaluations, others told us that they do not do such evaluations [26, 29]; yet, almost all of these firms have adopted costly top brand ERP systems. Our observations are similar to those made by Kumar [37] and Seddon et al. [64] where these researchers discussed the poor state of IS systems evaluations in organizations. Seddon et al. [64, p. 11] concluded, "…many firms do not conduct rigorous evaluations of all their IT investments" perhaps due to a lack of knowledge in such areas. Further evidence of this lack of knowledge regarding how firms assess the benefits of their ERP systems is provided in the survey of 232 respondents in American organizations that Robbins-Gioia [53] conducted. The survey reported that "46% of the participants noted that while their organization had an ERP system in place …, they did not feel their organization understood how to use the system to improve the way they conduct business." Indirectly, this information might be suggesting that ERP adopting firms do not know what to assess or evaluate to ensure that the technology enables them realize their organizational goals.

Similarly, research in the area of ERP systems success measurement, evaluations or assessment is just beginning to surface (see [47, 57-61, 69, 74]) in comparison to the other aspects of ERP studies including the adoption and implementation of such technologies that are readily available in the literature [e.g., 1, 3, 17, 39, 71]. Thus, lack of knowledge on the part of some practitioners about what to measure or assess in the context of ERP systems is the primary motivation for this study. Secondly, the paucity of research into ERP systems success evaluations in the extant IS literature is another motivation. In some respects, we aimed at responding to the calls made by researchers (e.g. [3, 68]) for more studies to investigate other aspects of ERP. More specifically, this present work seeks to complement the efforts of Gable and colleagues [20, 57, 60] toward the development of a measurement model for enterprise (ERP) systems.

Toward that end, our main purpose is to present an extended ERP systems success measurement model or framework that could be of use to organizations where such systems are being adopted. Likewise, the information systems (IS) community could benefit from our endeavor as we replicate and enhance knowledge in this area of research [7, 33, 57-61]. We ask the following questions: Are the dimensions of success represented in the ERP systems success measurement model proposed by Gable and colleagues comprehensive? If otherwise, can their model be extended to include any other relevant dimensions? Is "ERP systems success measurement model" a second-order factor as suggested by Sedera and Gable [60]? Which dimension(s) may serve as the best surrogate of ERP success?

Importantly, our focus is on private organizations in contrast to the public sector organizations that Gable and colleagues studied in Australia [20, 57-61]. Mansour and Watson [40], writing about the performance of IS in organizations, asserted that a government environment differs from a private one because of the intense competition usually seen in the latter, and a recent study [28] in the region of this study indicated that differences exist on the evaluations of key IS issues between organizations in both sectors. Thus, we contend that obtaining empirical evidence from private organizations (firms) with regard to their ERP systems success assessment will be relevant for practitioners from that sector because generalizing research findings across

both sectors could be misleading (see e.g. [28, 50]).

The remainder of the paper is structured as follows: Section 2 briefly discusses the research setting. Section 3 provides a review of the relevant literature. Section 4 describes the research methodology and results. Section 5 presents the data analysis. The discussions and conclusion are presented in Section 6.

RESEARCH SETTING

This research is conducted in Finland and Estonia (i.e., two small neighboring technologically advanced Northern European countries) with a combined population of approximately seven million people [27, 73]. Finnish companies began adopting ERP systems in the late 1990s [24, 26, 38, 71] and the software is beginning to spread to other parts of Europe, including Estonia where the technology is ranked among the top ten key IS management issues for the mid-2000s [28-30]. SAP is among the most popular ERP software in Finland, whereas Estonian firms tend to procure mid-market products like Scala and Navision [26, 29, 30], perhaps due to cost considerations or factors. Finland and Estonia share similar cultural values [25, 27, 44]. It is important to point out this fact because researchers (e.g. [67]) suggest national culture might have a bearing on ERP processes implementation. Thus, although our data comes from two different countries, we are assured of the homogenous nature of the sample on a major differentiator, namely, cross-national cultural differences.

Furthermore, van Everdingen et al. [71] noted that the penetration rates of ERP systems among midsized companies in the Nordic region were higher in comparison to those of other regions in Europe. They attributed this to the cultural factors of countries in the region and stated, "This cluster [of countries] is recognized as the most innovative cluster with relatively weak resistance to new products and a strong desire for novelty and variety" (p. 29). Thus, the relevance of our research setting with respect to ERP system acquisitions is recognized in the literature.

BACKGROUND

Our definition of ERP systems success refers to the utilization of such systems to enhance organizational goals (e.g. see [20, 22, 45, 46, 69]. In the IS literature, the term "success" has been used synonymously with effectiveness [22, 41, 70], and we concur with Thong et al. [70, p.252] when they stated that effectiveness of an IS can be "defined as the extent to which an information system actually contributes to achieving organizational goals." In brief, organizations want an IS that permits ease of use, reliability, and so forth. Further, the information output of the systems must be adequate, usable, etc [15, 46]. The support systems for the IS should be effective [5, 70, 72], and the impact of the system on the organization (including individuals and groups) should be recognizable [15, 59, 66].

We stress that the "success" being referred to is different in scope from the technical installations for ERP implementation success [41-43, 69], and we intend not to consider financial or monetary measures because such measures have been criticized [9, 15, 55]. The use of such measures to evaluate the success of IS may have confounding effects with other factors (i.e., endogenous and exogenous) that are unrelated to the IS being assessed. Simply put, it is a difficult task to determine the extent to which an IS contributes to an organizational performance when financial or monetary measures are employed for analysis [5, 9, 15, 55].

That said, our scan of the literature reveals that a few researchers (e.g. [47, 74]) have discussed ERP systems success by using the end-user satisfaction instrument [16, 32]. Despite the popularity of that instrument, criticisms have been leveled at it for its limited focus [e.g., 55]. Tan and Pan [69] developed a framework for ERP systems success assessment by including both technical and strategic valuation of ERP systems success, but using their framework might be difficult because of its lack of validation – it was developed using qualitative data. In their framework, Markus and Tanis [41] elaborated on enterprise systems success wherein a variety of factors including the phases of implementations, performance metrics, and outcomes were discussed. However, Markus and Tanis [41, p. 200] noted that their "theoretical framework … is too broad in scope for direct empirical testing. Essentially, the work of Gable and colleagues [20, 57, 60] provide perhaps the most comprehensive ERP systems success measurement model to

date. Their model is validated, and has been used in other studies (e.g. [58, 65]).

Our first objective was to find out whether the Gable and colleagues' ERP systems success measurement model is comprehensive. To provide an answer to this question, we consulted the literature and conducted case interviews with seven ERP adopting private firms in Finland and Estonia. The findings of the case studies are discussed in-depth elsewhere [26, 29]. In summary, these case studies provided us with useful insights. We will discuss our major finding in that regard below. With respect to the ERP systems success model proposed by Gable and colleagues [20, 57, 60], we believe presenting an overview of IS evaluations research in general will be enlightening given the fact that these researchers developed their model from the extant literature in this area of IS research.

Over the past three decades, evaluating the value and success of IT systems for organizations has been a recurring issue [e.g., 5, 6, 8, 9, 15, 16, 22, 45, 46, 64], and various assessment approaches have surfaced. One stream of research focuses on the use of attitudinal, perceptual, and subjective measures [16, 32], while another utilizes financial and objective parameters [e.g., 6, 9, 51]. In both instances, understanding the success or effectiveness of the IT systems could be limited when the dimensions and measures of success are restrictive [5, 8, 22, 46]. Thus, perhaps it was the plethora of IS success assessment approaches that led Keen [33] to seek clarification of the "dependent variable." In response, DeLone and McLean [15] developed an integrated, multi-dimensional, and inter-related IS success model. Please see Figure 1. (The acronyms are provided below.)

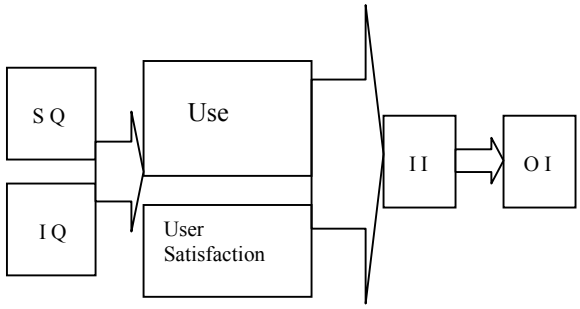


Figure 1: DeLone and McLean (1992) IS Success

DeLone and McLean [15] themselves noted that it is unlikely that any single, overarching IS success evaluation measure will emerge and advised that a combination of measures are necessary for evaluating IS success, and commented:

"Researchers should systematically combine individual measures from the I/S success categories to create a comprehensive measurement instrument. The selection of success measures should also consider contingency variables, such as the independent variables being researched; the organizational strategy, structure, size, and the environment of the organization being studied; the technology being used; and the task and individual characteristics of the system under investigation." [15, p. 87-88].

Regarding ERP systems success evaluations, perhaps the foregoing statement might have stimulated Gable and colleagues [20, 57, 60] as they developed an additive model that redefines the dimensions in the original DeLone and McLean IS success model. Specifically, Gable and colleagues noted that Seddon and Kiew [62] tested paths in the DeLone and McLean model finding support for some but not for the others. More recently, Iivari [31] investigated the paths in the DeLone and McLean model reporting no relationships between Use and Individual Impact. In brief, Gable and colleagues eliminated (through multi-stage data collection and statistical analysis) the Use and User satisfaction dimensions. Arguments against dropping these dimensions are also available in the literature [5, 8, 55, 61, 63]. In their arguments for the mutual exclusivity of success dimensions, Gable et al.

[20] suggested an overarching view of success in which "each measure [and/or dimension] only addresses one important aspect of IS success" (p. 578]. The ERP systems success dimensions retained in Gable and colleagues' model are as follows: System Quality (SQ), Information Quality (IQ), Individual Impact (II) and Organizational Impact (OI). Please see the illustration of their model in Figure 2.

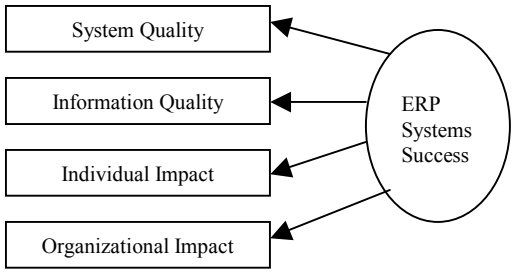


Figure 2: Gable et al. (2003) ERP Systems Success Measurement Model

The directions of the arrows in Gable et al. model are artifacts of statistical analysis. These authors in their analysis used LISREL a statistical tool that tends to support reflective models, in contrast to the tool used in this study, PLS Graph 3.0, that can support formative models as well as reflective ones [10-12, 21]. Gefen et al. [21] provide a good explanation of these terms; according to them, "When a construct, such as intelligence, cannot be measured directly, researchers measure it indirectly using several indicator variables… When the scores are assumed to measure the same underlying aspect of intelligence, they are reflective…. On the other hand, when more than one aspect of intelligence is being measured, such as when the exam tests both algebraic and linguistic intelligence using one indicator variable each, then the indicator variables would be formative of a construct for intelligence" (p. 31). In the Gable et al. [20] ERP success measurement model, the directions of the arrows are consistent with illustrations relating to a reflective model, and ours in Figure 3, formative.

In our effort to contribute to research in this area and to propose a more comprehensive success measurement model for ERP systems, we posed our second question: Can this measurement model be extended to include other relevant dimensions? Our arguments in this regard are twofold. As noted, firstly, we consulted the literature to determine whether Gable and colleagues have not considered any relevant dimension. Secondly, our qualitative research study in case companies [26, 29] yielded useful insights. We discuss the two issues as follows.

Myers et al. [45] argued that any IS success model should incorporate Workgroup Impact (WI) because of the contributions made by work teams/groups toward organizational productivity, and these authors added this dimension of success to the DeLone and McLean model. Importantly, our notion of "workgroup" encompasses sub-units and/or functional departments of an organization. Essentially, the underlying philosophy of ERP systems (see, [13, 14, 35, 41]) underscores the arguments of Myers et al. [45]. Namely, ERP systems are usually acquired to enhance efficient cross-functional operations within the adopting organization [1-3, 13, 14, 41, 71]. Of note, "interdepartmental co-operation" and "interdepartmental communication" ranked 3rd. and 6th. respectively in a study of 22 critical success factors (CSFs) of ERP implementation by Akkermans and van Helden [1]. Other ERP CSFs studies have produced comparable analysis (see [17]).

Furthermore, we contend that another dimension named Vendor/Consultant Quality (VQ) can be incorporated into the Gable and colleagues model. Empirical evidence with 16 senior personnel in seven case companies in Finland and Estonia revealed that these ERP adopting firms tend to associate the role and quality of the providers (vendors and consultants) of their software with its overall success for the organization [26, 29]. One interviewee captured the views of others when he commented:

"As for me, I consider the support from the vendor, their expertise and commitment levels to be critical to our ERP success" (Finance Director/Head of IT, Estonian manufacturing firm) [29]. The fact that our respondents accord importance to the roles and quality of ERP providers (i.e., vis-à-vis achieving organizational goals) is surprising to us as this is at variance with established thinking of IS success measurement or evaluations. The literature usually discusses IS success using a few or a combination of the six dimensions of success that DeLone and McLean elaborated.

Nonetheless, DeLone and McLean [15, p.88] themselves stressed that "individual characteristics of the system under investigation" should not be neglected. Thus, perhaps the findings from the field study reflect this reality. Indeed, the role and quality of vendors/consultants throughout the life span of any ERP adoption has been described as being imperative for any ERP acquisition [13, 14, 24, 36, 41, 68, 72]. Markus and Tanis [41] highlighted "dependence on vendors" as a key issue in ERP implementations that differentiate these systems from other IT implementations. Studies [e.g., 36, 58, 72] have shown that the engagement of external expertise is essential for the effectiveness of ERP systems in adopting organizations. We believe a favorable implementation scenario will translate to positive outcomes at latter stages in the life cycle of the software [13, 14, 17, 36, 39, 41, 72].

Some may argue that Vendor/Consultant Quality might be a relevant exogenous factor required for the ERP success and not a dimension of success, per se. On our part, we argue that the literature has noted that IS success (including the emerging concept of ERP success) is an elusive and ambiguous concept that is pervaded with varying IS success constructs. In fact, our scan of the literature indicates that this paper is not the first to propose a model of IS success that acknowledges (and incorporates) the relevance of a comparable dimension at the consulting/technical support level. Ballantine et al. [5] provided a comprehensive critique of the DeLone and McLean IS success model and proposed an alternative IS success measurement model to the DeLone and McLean model which they called "a 3-D model of IS success" with three fundamental dimensions or levels. These include the technical Development, the Deployment to the user, and the Delivery of business benefits. Further, their model was comprised of issues such as "support and maintenance", "IS professional skills and experience" [of the system developers], and "system type", among others. This perspective is consistent with our inclusion of Vendor/Consultant Quality as a success dimension.

Overall, the literature suggests that when the ERP vendor/consultant provides adequate technical support, has a good relationship with the adopting firm, and so forth, the transfer of relevant information and knowledge to the client is enhanced [36, 41, 70, 72]. (Recall an ERP is a complex system that could do with such facilities and arrangements). It can be argued that the client will be in a better position to use the acquired software efficiently and effectively in achieving organizational goals when such an arrangement exists. Accordingly, when this is the case, success with the software increases. At the same time, researchers [e.g., 5, 8, 15, 22, 62, 63] make arguments for inter-relationships and interdependency among constituting measures or dimensions of IS success models to be established in order to enhance the predictability value of any ensuing framework or model. In this light, we believe there is a strong link between the dimensions of Vendor/Consultant Quality and each of the other five [e.g., 58, 70]. In summary, given the importance that participants in our case studies attach to their ERP providers with regard to achieving overall success with the software [26, 29] and the various support from the literature, we believe a more comprehensive ERP systems success measurement model should incorporate this dimension.

Importantly, we grouped both vendors and consultants together because they represent an external source of expertise to the organization regarding ERP implementation, and in some instances an organization may deal with one entity representing both (see [51]). Sedera et al. [58, p.1411] found that "consultant and vendor items loaded together yielding a new factor named External knowledge player." Also, when the implementations of such systems go awry both the vendor and consultant face a similar penalty [41].

Thus, our extended ERP systems success measurement model is shown in Figure 4 with two new dimensions: Vendor/Consultant Quality (VQ) and Workgroup Impact (WI) not included in the Gable et al. [20] model. Our ERP

systems success model is composed of subjective and perceptual measures because objective measures are difficult to quantify and obtain from organizations [39]. Next, we describe the research methodology which is followed by the criterion validity assessment and structural modeling discussions. This would enable us to find answers to the remaining questions, i.e., Is "ERP systems success measurement model" a second-order factor? And, which dimension(s) is the best surrogate of ERP success?

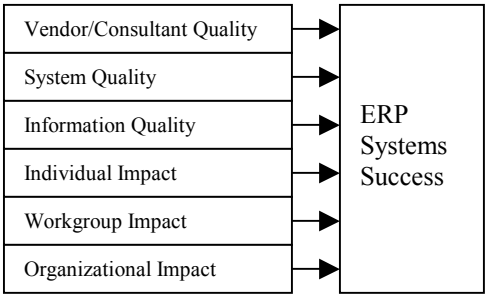


Figure 3: The Extended ERP Systems Success Measurement Model

METHODOLOGY

Research Method

Overall, the results in this study were obtained in a three-step fashion. We used both qualitative and quantitative research approaches to enhance the validity of our findings. We started by consulting the relevant literature before we conducted a preliminary survey. Next, we interviewed case companies in the two countries and finally carried out the main survey for the study which we elaborate in this paper. The preceding research phases will not be discussed here but are available elsewhere [29]. In summary, these preceding phases enhanced the content and face validity of the items used in this main phase.

The main survey was carried out from July to September 2005. It was impossible for us to determine the number of firms adopting ERP in Finland and Estonia as limited funds did not permit us to determine such information. We decided to sample firms generated from local contacts, ERP User Groups and vendors lists, as well as published lists of Top Enterprises for 2004 for both countries. Firms were chosen by our ability to obtain contact addresses for key organizational personnel. We identified 350 firms in Finland and 120 firms in Estonia. In order to ensure data validity and reliability, four knowledgeable individuals (i.e., 2 IS faculty, 1 ERP consultant and 1 ERP managerial level user) completed the questionnaire prior to our mailing it, and their comments helped us improve its quality. Respondents in our survey indicated agreement with statements using a 7-point Likert-type scale, where 1 = strongly disagree and 7 = strongly agree. A few of the statements are shown in Table 1, and the full list is shown in the Appendix. The questionnaire also had sections for other information such as company turnover, workforce, ERP type, and demographic profiles.

Since the unit of analysis of this study was at the organization level, only key organizational informants received a packet consisting of a cover letter, questionnaire, and a self-addressed, stamped envelope. The literature suggests that when a key informant is used in research, the individual most knowledgeable about the issue of interest should be chosen [see e.g., 70]. For this study, we focused on top- and mid-level managers from both the business and technical (IT) side of the organizations. These groups of respondents are among the most knowledgeable informants regarding ERP systems success evaluations in adopting organizations [20, 59, 66]. Examples of their job titles are provided below.

About sixty percent (60%) of the mailings included only one questionnaire; the rest (40%) of the mailings have two questionnaires. Low response rates seen with IS studies in the region as discussed in Nissinen [48] prompted us to use this method. Also, it was decided that mul-

tiple respondents from one organization would enhance the validity of the study as a common source bias would be minimized. All the participants in the study were encouraged to give one of the questionnaires to an appropriate person within their organization. We encouraged the subjects to present views representative of their organization. To ensure that organization-wide perspectives are being reflected, we posed the questions in the questionnaire appropriately (please see the Appendix).

Regarding the reliability of our measures, we developed the research instrument that benefited from our case studies [29] and other measures and constructs validated in the literature [20, 57, 60]. Table 1 shows the sources of some of the measures and the reliability of the research variables. Clearly, the Cronbach Alpha for each dimension is above the 0.70 limit recommended by Nunnally [49], indicating a reasonably high reliability of the research measures.

Table 1: ERP Systems Success Dimensions, Sources, and Reliability

Dimension	No. of measures	Cronbach Alpha	Sources	Examples of questions in the instrument
System Quality	11	0.852	[15, 20, 57, 60]	"Our ERP is easy to use." "Our ERP is reliable."
Information Quality	8	0.822	[15, 20, 57, 60]	"The information on our ERP is understandable." "The information on our ERP is relevant."
Vendor/Consultant Quality	5	0.876	[36, 70]	"Our ERP vendor/consultant is credible and trustworthy." "Our ERP vendor/consultant has good relationships with my organization"
Individual Impact	6	0.769	[15, 20, 46, 57, 60]	"Our ERP improves individual productivity." "Our ERP is beneficial for individual's tasks."
Workgroup Impact	7	0.810	[15, 29, 45, 46]	"Our ERP helps to improve workers' participation in the organization."
Organizational Impact	8	0.867	[15, 20, 46, 60, 66]	"Our ERP reduces organizational costs." "Our ERP increases customer service/satisfaction."
(Overall) ERP Systems Success measures	3	0.942	[20, 57, 60]	Overall, the impact of our ERP on **i)** me has been positive **ii)** my workgroup (department) has been positive **iii)** my organization has been positive

Results

We used SPSS 13.0 to analyze the data. Our respective response rate, excluding the unusable received questionnaires was 29 firms (8.5%) for Finland, 15 firms (12.5%) for Estonia, and 44 (9.5%) combined for the two countries. We received 62 individual responses (i.e., 39 from Finland and 23 from Estonia). Our data classified by hierarchy was comprised of 26 (42%) top-level management and 36 (58%) mid-level managers; by occupation 20 of the respondents (32.3%) were IT professionals/managers and 42 (67.7%) business managers. Specifically, their job titles included chief executive officer, chief information officer, chief accountant, IT manager, SAP analyst, business analyst, and finance manager. There were 35 (56.5%) men and 27 (43.5%) women in our sample. On average, they had 9 years of work experience in their respective organizations. Of the respondents, 40% had college degrees and 20% had technical and other vocational education; 43 (69.3%) were between 31 and 50 years old.

Of the 62 respondents, 33.9% had SAP in their organizations, 14.5% had Movex, 9.6% had Scala, 8.1% had Hansa, and the remaining 33.9% had other mid-market ERP (including Concorde, Nova, etc.). The majority of firms implemented their ERP between 1998 and 2002. The annual turnover of the firms in the sample

ranged from €1 million to a little over €2 billion, with €19 million as the median. The workforce ranged from 10 to 13,000 employees, with a median of 120 employees. We received responses from a wide range of industries, including manufacturing, financial services, IT firms, pharmaceuticals, food processing, retail, and warehouse businesses.

Our sample, classified by size of workforce, following guidelines provided by EC [18] and Laukkanen et al. [38], included 15 (24%) small companies, 22 (36%) large firms, and 25 (40%) medium-sized. It is difficult to establish whether the firms in our sample are representative of the population of firms in the two countries that have adopted ERP since no demographic information on ERP adoption is available, as indicated above. However, our data is consistent with the study by Laukkanen et al. [38] indicating that ERP adoption in Finland is higher in the retail and manufacturing sectors. Our earlier study [26] suggested that SAP is the most common ERP software among large firms in Finland. Additionally, our sample size compares favorably with those used by Laukkanen et al. [38], and our informal discussions with ERP consultants in the two countries confirmed that small and medium-size firms in the region usually adopt mid-market ERP products (i.e., Movex, Scala, Hansa, etc.), as our data showed. Finally, to assess whether our respondents reflect the sampling frame of ERP adopting firms in the two countries, we compared early and late respondents in the study on key organizational characteristics such as size, industry type, year of ERP adoption, and ERP type, among others (i.e., nonresponse bias). The results of the chi-square tests (significant at < 0.05) showed there were no significant differences along these key characteristics.

Additive Nature of the ERP Systems Success

Following guidelines in Gable et al. [20], we assessed the additive nature of our model by investigating the criterion validity of the measures in our instrument. We assessed our ERP systems success using the following three statements: (A) "Overall, the impact of our ERP on me has been positive," (B) "Overall, the impact of our ERP on my workgroup has been positive," and (C) "Overall, the impact of our ERP on my organization has been positive." To assess the content and the criterion validity of ERP success, we computed the following composite measures: (D) "criterion average" is the average of the three criterion items, and (E) "dimensions average" is the average of the six success dimensions. Table 2 shows the correlation of (A), (B), (C), and (D) with the six dimensions and their average (E). Gable et al. [20, p. 585] state, "The extent to which each dimension or the dimensions average correlates with the criterion scores is evidence of their criterion validity". (Please see [34]).

Table 2: Correlations - Criteria Measures and Dimensions

	Dimension (Construct)	Impact on Individual	Impact on Workgroup	Impact on Organization	Criterion Average
1	VQ	.41	.42	.40	.43
2	SQ	.55	.54	.64	.61
3	IQ	.59	.58	.63	.64
4	II	.51	.57	.60	.59
5	WI	.60	.58	.57	.62
6	OI	.70	.61	.67	.69
E	Dimension Average	.70	.68	.72	.74

The correlations are significant at the 0.01 level (two-tailed), with the exception of the correlation between "Organization Impact" and "Impact on Individual" which is 0.70. The three largest correlations are for (A), (C), and (D) with (E), which are respectively 0.70, 0.72, and 0.74. Consistent with Gable et al.'s study [20], the largest correlation (0.74) is between (D) criterion average and (E) dimension average which suggests that (D) and (E) are the strongest measures of overall ERP systems success. These results provide support that the dimensions in our suc-

cess framework or model are additive. Gable et al. [20, p. 585] noted, "That the dimensions average yields the largest correlation with all the criteria further supports the view that the dimensions are additive, and thus when combined yield a stronger overall measure of success than possible from any single dimension."

Further, we used PLS Graph 3.0 to assess the extended model (Figure 4). The PLS (Partial Least Squares) procedure is a second-generation multivariate technique used to estimate structural models [10-12, 21]. This approach is suitable for this discourse for three reasons: 1) It is not sensitive to normality of data (our data is non-normal as indicated by Kolmogorov-Smirnov statistic), 2) The small-sized nature of our data, and 3) The developing knowledge regarding the additive nature of IS success measurement. PLS is capable of testing complex models consisting of multiple interactions measured with multiple indicators. Unlike the traditional multiple regression analysis that is less efficient in assessing measurement errors, PLS recognizes two components of a casual model: the measurement model and the structural model [10-12, 21].

The measurement model consists of relationships among the conceptual factors of interest (the observed items or variables) and the measures underlying each construct. This model demonstrates the construct validity of the research instrument (i.e. how well the instrument measures what it purports to measure). The two main dimensions are the convergent validity (composite reliability) and the discriminant validity. PLS Graph 3.0 computed the composite reliability of each dimension or construct. The composite reliability of each construct in the model in our proposed model are as follows: SQ -- 0.71; IQ -- .60, VQ -- 0.50, II -- 0.58, WI - - 0.45, OI -- 0.63, ERP success -- 0.77, which is adequate for a preliminary study such as this one [23].

The discriminant validity is assessed by checking the extent to which items measure a construct. This is assessed by checking the square root of the average variance extracted (AVE) for each construct. Table 3 presents the inter-correlations among the constructs, AVE and the square root of AVE for the extended ERP success measurement model (Figure 3). Fornell and Larcker (1981) recommends that AVE values should be at least 0.50 and that the square root of AVE should be larger than off-diagonal elements. Our data did not meet the first requirement, but meets the second. In no case was any correlation between the constructs equal to or greater than the squared root of AVE (leading diagonal) [11-12, 19]. This suggests that our measures are distinct and unidimensional. Thus, we can tentatively say that the convergent and discriminant validity of our data are psychometrically adequate for this exploratory study [19, 21, 23].

Table 3: Correlations of Latent Constructs

Construct	AVE	SQ	IQ	VQ	II	WI	OI	ERP success
SQ	0.22	**0.47**						
IQ	0.19	0.28	**0.44**					
VQ	0.20	-0.02	0.17	**0.45**				
II	0.23	0.26	0.08	0.11	**0.48**			
WI	0.15	-0.07	-0.09	0.05	-0.14	**0.39**		
OI	0.23	0.45	0.32	0.05	0.12	-0.03	**0.48**	
ERP success	0.54	0.42	0.29	0.11	0.28	-0.29	0.45	**0.73**

Notes: The elements in the leading diagonal are the square roots of AVE.

The structural model gives information as to how well the theoretical model predicts the hypothesized paths or relationships. PLS Graph 3.0 provides the squared multiple correlations (R^2) for each endogenous construct in the model and the path coefficients. The R^2 indicates the percentage of a construct's variance in the model, while the path coefficients indicate the strengths of relationships between constructs [10-12, 21]. PLS does not generate a single goodness of fit metric for the entire model, but the path coeffi-

cients and the R^2 are sufficient for analysis [10, 11].

Alternative Models

It is suggested that the examination of alternative models in structural modeling research could facilitate insights [16, 21, 23, 60]. Thus, we developed Model 1 to Model 6 and checked their path coefficients and R^2s as well. The details of these models are shown in Table 4. See also Figure 4 for their diagrammatic illustrations. The R^2 of Models 1, 2, 3, 4, 5, and 6 respectively are 0.196, 0.052, 0.234, 0.079, 0.067, and 0.068. In this preliminary study, we decided not dilute the focus of the discourse by presenting the PLS graph 3.0 results (i.e., convergent and discriminant validity) for each of the models; however, this will be highlighted when the confirmatory study is discussed.

Table 4: Structural Models and their Corresponding R^2s

R^2	Structural Model	Description
$\mathbf{R^2}$ = 0.196	Model 1	One first-order factor, with all the 45 items
$\mathbf{R^2}$ = 0.052	Model 2	Six first-order factor (SQ, IQ, VQ, II, WI, OI), One 2nd order factor
$\mathbf{R^2}$ = 0.234	Model 3	Six first-order factor, Two 2nd order factors, One 3rd order factor
$\mathbf{R^2}$ = 0.079	Model 4	Four first-order factor (SQ, IQ, II, OI), One 2nd order factor (Gable et al. [20]
$\mathbf{R^2}$ = 0.067	Model 5	Five first-order factor (SQ, IQ, II, WI, OI), One 2nd order factor (without VQ)
$\mathbf{R^2}$ = 0.068	Model 6	Five first-order factor (SQ, IQ, VQ, II, OI), One 2nd order factor (without WI)

Clearly, Model 3 has the best R^2 suggesting its relative strength in predicting ERP success in comparison to the other models. Notably, it explains 23% of the variance in the ERP success construct. Beside Model 1 that explains approximately 20% of the variance in the ERP success construct, all the other models including the Gable and colleagues' and the extended model (Figure 3) explained about 5-7% of the variance. The finding in relation to Model 3 is inconsistent with results in the work of Sedera and Gable [60] suggesting that ERP success might be a second-order factor. We have not suggested that our work is a complete replication of Gable and colleagues' efforts. There are major differences between this study and those by Gable and colleagues'. For example, their sample size is larger than ours (i.e., they used more than 300 respondents in their survey). They used 27 public sector organizations as opposed to ours with 44 diverse private firms. They used only one ERP type, i.e., SAP, and they considered views from across all employment cohorts, including top, middle, and lower level employees. Here, we excluded the views of junior workers. Our data analysis showed that all the models (i.e., 2, 4, 5, and 6) having the dimensions of ERP success modeled at the second-order level yielded comparable results (i.e., path coefficients). However, we use Model 2 (the PLS Graph 3.0 path coefficients results are shown in Figure 6) to briefly discuss the ability of each dimension if used as a surrogate of ERP success. (Note that all the dimensions that we discussed in the paper are represented in this particular model). Chin [11] recommends that path coefficients should be at least 0.20 and ideally above 0.30 to be considered meaningful.

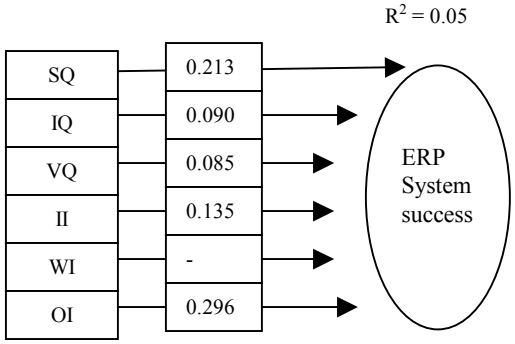
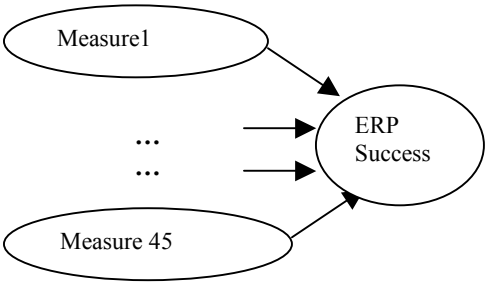
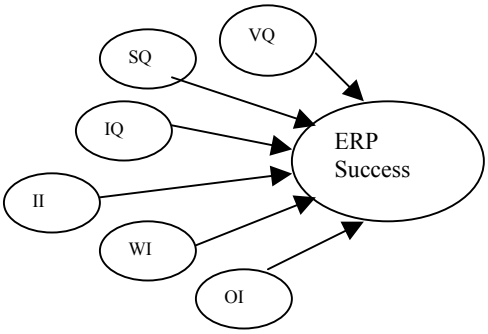


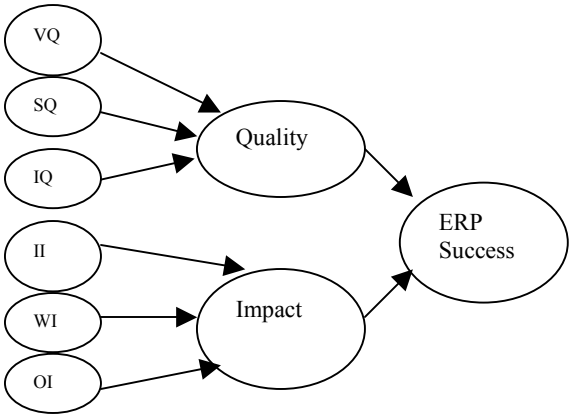
Figure 5: PLS 3.0 Results for Model 2



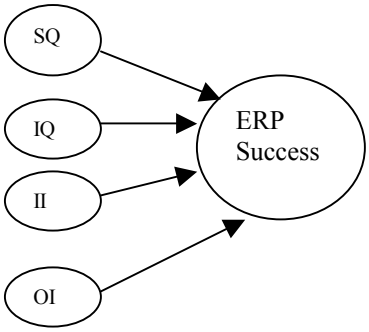
Model 1: One first-order factor, with all the 45 items (see the Appendix)



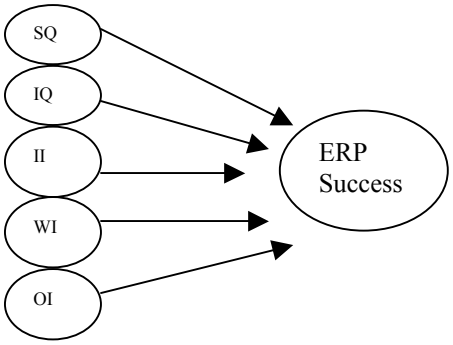
Model 2: Six first-order factor and one 2nd order factor



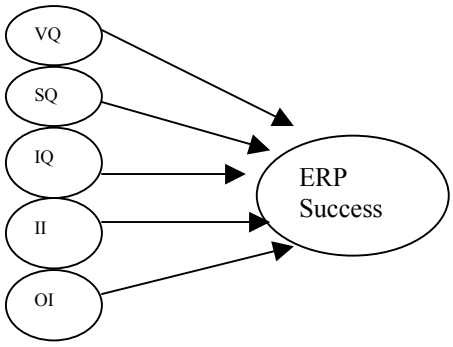
Model 3: Six first-order factor, Two 2nd order factors, one 3rd order factor



Model 4: Four first-order factor (Gable et al. [20])



Model 5: Five first-order factor, one 2nd order factor (without VQ)



Model 6: Five first-order factor, one 2nd order factor (without WI)

Figure 4: Illustrations of the Alternative ERP Systems Success Models

Clearly from Figure 6, System Quality (SQ) and Organizational Impact (OI) appear to predict "success" more than do any other dimensions. The relatively high path coefficient on the Organizational Impact dimension is perhaps a reflection of the capability of ERP to provide tangible benefits for adopting organizations [13, 14, 20, 39, 41, 59]. Thus, it may be safe to say that this dimension could serve as the best indicator of ERP success for firms adopting such software. The System Quality (SQ) dimension came in second with a good path coefficient; this could be interpreted as indicating that firms adopting such software would more readily evaluate the quality and features of their software vis-à-vis its success than they do for the other remaining four dimensions of success. Individual Impact (II) comes next and it should be noted that ERP adoptions tend to be focused more on achieving effectiveness for the organization than for improving individual impacts [13, 14, 35]. Recall that the participants in this study are higher level employees; it is likely that their positions may not permit them to reflect individual impacts of ERP systems as opposed to lower level employees (e.g., clerks) who tend to use such systems more, and thus may present a different viewpoint [56].

The next two items (i.e., Information Quality and Vendor/Consultants Quality) do not appear to be as important as the preceding three in predicting ERP systems success in adopting organizations even when some participants had noted the relevance of Vendor/Consultants Quality in success evaluations of ERP systems. A plausible explanation might be that firms are not satisfied with the quality of information in ERP systems. In fact, Sammon et al. [54] have raised concerns regarding the informational quality of ERP systems in general and the misleading roles that the vendors of such systems play when promoting the capabilities of their software. Thus, the two dimensions (IQ and VQ) may not be among the topmost concerns for firms when assessing the success of their software. This is not to suggest, in any way, that firms do not value the informational capabilities of their ERP and the roles that the providers of such technologies play [see, 29, 30, 54].

Finally, the Workgroup Impact (II) did not yield any meaningful information with its inverse connotations. We attribute this to two facts: 1) the nature of our data. We noticed that some small-sized firms did not rate measures relating to this dimension highly perhaps because of the nature of their organizations, namely, they may have less need to work in diverse functions and departments, and 2) there is no validated instrument for measuring this dimension. Before discussing the study's implications, etc., we will briefly discuss its other limitations.

The Limitations of the Study

Overall, there are other limitations to this study. It is exploratory, and although a convenient sample of 62 respondents may be adequate in these two small countries, it is insufficient for a conclusive understanding of the issue. Nonetheless, our sample size compares favorably with other ERP studies emanating from the region [e.g., 38]. Our sample is not random nor can we rule out personal bias in instances when a single informant presented an average view of his respective organization. We used subjective and perceptual measures in this study; it is likely that objective measures of ERP success (e.g., profit and productivity measures) might yield a result different from ours. Additionally, our sample comprises mixed ERP software, including top-brand names (e.g. SAP and Oracle) and mid-market products (e.g. Hansa, Scala, and Nova). It is possible that the heterogeneous nature of the ERP systems used for our study are limiting. It is difficult to generalize the findings of the study to public sector organizations.

Although managers in Finland and Estonia have a good command of the English language, there is a possibility that completing the questionnaire in a foreign language might have posed a problem and that some issues were misunderstood. Finally, our sample consists of small, medium, and large companies. The diversity in the sample is good, but it may affect our findings. A homogenous sample of only large or small firms might yield results different from the ones discussed herein.

DISCUSSIONS AND CONCLUSION

This paper discusses the ERP systems success measurement model as proposed by Gable and colleagues [20, 57, 60]. We asked whether the ERP systems success measurement model proposed by these researchers is compre-

hensive. We found through literature review and interviews with case companies that their ERP systems success measurement model might be limited in scope as two vitally important dimensions are not being considered. To that end, this paper presents perhaps the first attempt at replicating, validating and extending their model, and in a different setting (private sector) and geographical location. As clarified, this present study is not a perfect replication of the Gable and colleagues' effort and our findings can only serve to stimulate further investigations.

Importantly, this paper draws from the work of these researchers with regard to the issues of additivity and mutually exclusivity of ERP success measures. We incorporated two relevant constructs or dimensions, namely Workgroup Impact and Vendor/Consultant Quality, which we found to be relevant in the discourse of ERP systems success. Thus, our operationalized set of dimensions and measures offers perhaps a more comprehensive model in the literature regarding ERP systems success measurement. The measures or items used to assess the reliability of the extended ERP systems success measurement model were adequate. On the other hand, its psychometric properties we believe can be improved when some of the limitations in this study are tackled. The criterion validity of the measures was adequate and compares with those in Gable and colleagues' studies. Additionally, our model offers other useful insights, for example, System Quality (SQ) and Organizational Impact were found to be perhaps the two most important dimensions to watch out for in evaluating ERP systems success, at least in private organization settings. In other words, these dimensions might provide the best information for adopting firms regarding ERP success (or their use as surrogates of ERP success).

At a general level, this study responds to the ongoing calls by researchers (e.g., [3, 68]) for ERP studies to be extended to wide-ranging areas other than the putative issues of adoption and implementations of such systems [see, 17]. Prior studies tend to concentrate on ERP adoption and implementation success issues, and rightly so as ERP was introduced to the IS community only by the late 1990s [13]. We believe the time is ripe, however, for issues relating to success evaluations of the technologies in adopting organizations to take center stage, and this study is an initial effort in that direction. Our study is among the first attempts at developing a scale for the Workgroup Impact dimension suggested by Myers et al. [45], which incidentally is relevant for enterprise systems because such technologies have the capability to integrate diverse organizational functions and departments.

Our effort in this area of study, in many respects, could entice further studies. Particularly, this study might engender the development of an appropriate scale to assess ERP systems success for adopting organizations. Admittedly, this study has benefited from the direction for future research on IS success evaluations that DeLone and McLean [15, pp. 87-88] highlighted, as we attempt to consider in full the imperatives of a particular IS, namely, ERP systems. We did not restrict ourselves to the use of established IS success measurements that ignore relevant issues relating to ERP systems. We hope future endeavors wishing to develop a comprehensive framework that incorporates the impact of contingency variables, such as organizational strategy, structure, and size, among others would benefit from our perspective on ERP systems success assessment. It has to be noted, however, that the findings of this preliminary study are not conclusive and further testing and refinements are expected. Future research might need to focus on utilizing confirmatory factor analysis as knowledge is accumulated in this area of research. According to Sedera and Gable [60, p.449], "A confirmatory analysis is needed to facilitate a more rigorous, standardized survey instrument with validated items." The validation and replication of the extended ERP systems success measurement model are expected as such replications are useful for cumulative knowledge in this area of research, in particular [60], and to the IS domain, in general [7, 15, 33].

This study has implications for practice as well. As noted, this study is partly motivated by the need to present practitioners with guidelines for assessing the success of their ERP software. It is not claimed that our guideline is the final word regarding ERP systems success measurement, evaluation or assessment for ERP adopting organizations; however, our comprehensive list of success dimensions and measures could be valuable in this regard especially for firms with no formal means of conducting such an exercise [26, 29, 37, 53, 64]. It is worth noting that anecdotal evidence exists indicating that our research instrument, in particular its aspect as

shown in the Appendix, is already in use, for such purposes, in our research settings. Furthermore, management (at least, in the context of this research setting) can use the dimensions of System Quality and Organizational Impact of acquired systems in assessing the effectiveness or success of such technologies in instances where a more comprehensive scale or formal evaluation techniques are not readily available. We might as well add that a practical way to use our ERP systems success measurement model would be to use the "Quality" constructs and their measures to assess situations with the ERP software during the early periods preceding acquisition and use the "Impact" items for latter periods when the impact of ERP to the workgroups and the entire organization are to be assessed.

Organizational hierarchy could be considered when such assessments are made. For example, the findings in Ifinedo and Nahar [30] and those by Sedera et al. [59] found that higher-level management staff tend to rate the "Impacts" measures higher than do others. Conversely, lower level employees who might be using such systems more than higher-level employees (e.g., [56]) could present a better assessment of the "Qualities" of such systems. Vendor/Consultant Quality remains a critical issue and dimension for the organization because of the dependency that is usually created when such systems are acquired. In addition, the extended ERP systems success measurement model can also be used for assessing the success of other enterprise systems such as Supply Chain Management (SCM) and Customer Relationship Management (CRM) systems following slight modifications. Lastly, the views presented in this paper represent those of higher-level employees in the firm, the opinions of junior workers especially on the "Quality" issues may differ, and it would be enlightening for a future study to investigate ERP success from that perspective.

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APPENDIX: THE MEASURES IN THE QUESTIONNAIRE

	Measures
1	Our ERP has accurate data
2	Our ERP is flexible
3	Our ERP is easy to use
4	Our ERP is easy to learn
5	Our ERP is reliable
6	Our ERP allows data integration
7	Our ERP allows for customization
8	Our ERP is efficient
9	Our ERP has good features
10	Our ERP allows for integration with other IT systems
11	Our ERP meets users' requirements
12	Our ERP database contents is up-to-date
13	Our ERP has timely information
14	The information on our ERP is understandable
15	The information on our ERP is important
16	The information on our ERP is brief
17	The information on our ERP is relevant
18	The information on our ERP is usable
19	The information on our ERP is available
20	Our ERP vendor/consultant provides adequate technical support
21	Our ERP vendor/consultant is credible and trustworthy
22	Our ERP vendor/consultant has good relationships with my organization
23	Our ERP vendor/consultant is experienced and provides quality training and services
24	Our ERP vendor/consultant communicates well with my organization
25	Our ERP enhances individual creativity
26	Our ERP enhances organizational learning and recall for individual worker
27	Our ERP improves individual productivity
28	Our ERP is beneficial for individual's tasks
29	Our ERP enhances higher-quality of decision making
30	Our ERP saves time for individual tasks and duties
31	Our ERP helps to improve workers' participation in the organization
32	Our ERP improves organizational-wide communication
33	Our ERP improves inter-departmental coordination
34	Our ERP creates a sense of responsibility
35	Our ERP improves the efficiency of sub-units in the organization
36	Our ERP improves work-groups productivity
37	Our ERP enhances solution effectiveness
38	Our ERP reduces organizational costs
39	Our ERP improves overall productivity
40	Our ERP enables e-business / e-commerce
41	Our ERP provides us with competitive advantage
42	Our ERP increases customer service/ satisfaction
43	Our ERP facilitates business process change
44	Our ERP supports decision making
45	Our ERP allows for better use of organizational data resource
46	Overall, the impact of our ERP on me has been positive
47	Overall, the impact of our ERP on my workgroup (department) has been positive
48	Overall, the impact of our ERP on my organization has been positive

Notes: (1) Assessed on a Likert scale (1=strongly disagree, 2=disagree, 3=somewhat disagree, 4=neutral, 5=somewhat agree, 6= agree, and 7=strongly agree). (2) [Our ERP] refers to the type(s) of ERP system in use in the participating firms.