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Knowing why and how to innovate with packaged business software

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Abstract

When firms move to adopt and implement a popular IT innovation, what knowledge must they have or gain, in order to be successful? Here we offer a model that explains a firm's success in terms of its adoption *know-why* and *know-when* and its implementation *know-how*. We examine this model in an exploratory survey of some 118 firms' adoption and implementation of packaged business software in the 1990s. Using multivariate methods, we identify *business coordination* as know-why and *management understanding* and *vendor support* as know-how factors important to success, explaining nearly 60% of the variance. There is limited evidence that the right adoption know-why may help in acquiring or fostering the right implementation know-how. The findings serve to remind practitioners that they should attend carefully to adoption rationales, grounded in business benefits, when they innovate with new IT.

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When firms move to adopt and implement popular IT innovations such as Enterprise Resource Planning (ERP), Customer Relationship Management (CRM), and Knowledge Management, which present substantial technological and organizational complexities, what knowledge must they have or gain, in order to be successful? For any particular IT innovation, consider that each firm faces three basic questions: *Why* should it make or not make the move? *When* if ever should it make it? *How* if at all should it proceed? To answer these questions, we suggest that the firm summons what may be termed its *know-why*, *know-when*, and *know-how* for the specific initiative, engaging in organizational *reasoning* to explicate and justify its choices. We conjecture that when firms subsequently succeed or fail, outcomes may be due in substantial part to the quality of this know-why, know-when, and know-how.

For instance, in the 1990s, many firms innovated with ERP (Davenport, 1998; Klaus *et al.*, 2000; Kumar and Van Hillegersberg, 2000), motivated by a variety of reasons (Ross *et al.*, 2003). Certain of this 'know-why' for ERP may have been better than other, because, for instance, it was a better match to the innovation's capabilities and limitations. Too, not all firms adopting ERP likely had the same capabilities to undertake it. Some no doubt summoned better 'know-how' and further exercised better 'know-when' than did others.

Notwithstanding this importance of the firm's knowledge and decision process, researchers who have studied organizational innovation more broadly have generally focused their attention elsewhere (Damanpour, 1991). In particular, they have sought to explain innovation outcomes as determined by organizational characteristics in conjunction with innovation type. Among researchers who have studied innovation with IT more specifically, a relative few have sought through case studies to open up the 'black box' of innovation decision making, revealing, for instance, its characteristic structure and politics (see, e.g., Orlikowski, 1993). Among other researchers, Fichman and Kemerer (1997, 1999) are notable for having studied knowledge barriers to successful implementation (Attewell, 1992). Observing that certain IT innovations seem to be more readily acquired than they are deployed, these authors suggest that studying firms' decision making to understand why this is so might be fruitful.

The present research also takes a knowledge-based perspective, suggesting that a firm's reasoning in innovating with

IT can be important to its relative success, and advancing a research model to this effect. More specifically, we explore here the know-why and know-how for innovating successfully with ERP packaged business software in the 1990s. Analyzing survey data from some 118 firms, we identify *business coordination* as know-why and *management understanding* and *vendor support* as know-how factors important to success with ERP. We find that a relatively simple version of the model allows us to explain nearly 60% of the variance in ERP success. Apart from providing support for our research model, which breaks new theoretical ground, our novel finding that know-why is important to innovation success reminds practitioners that they should attend carefully to adoption rationales, grounded in business benefits, when they innovate with new IT. Such 'business cases' are important not only to the adoption decision, but to monitoring subsequent performance. In the case of ERP, monitoring the achievement of business coordination benefits is called for, in particular. The balance of the paper presents in detail the theory and an explanatory model, the research method, the findings and their discussion, and, in conclusion, the implications for practice and further research.

Theoretical background

A firm *innovates* when it adopts and implements an idea, practice, or object perceived as new to it (Rogers, 1995: 11). Among a population of firms adopting a particular innovation, only a relatively few (some 16%) are considered the true innovators and early adopters (Rogers, 1995: Chapter 7). The majority (68%) follows their lead. The rest (16%) lags.[1] The diffusion of the innovation within the population involves substantially more *imitation* than it does invention (DiMaggio and Powell, 1983; Swanson and Ramiller, 1997).

Whether it leads or not, any firm innovating with IT seeks to improve upon its own IT-based competence (Attewell, 1992), in pursuit of firm objectives (Nelson and Winter, 1982). Broadly, the firm has both distinctive competencies in its industry, as well as competencies shared with others (Winter, 1987; Mata *et al*., 1995). In innovating with any particular IT, it seeks to improve upon its distinctive competence, its shared competence, or both. True innovators and early adopters may seek the competitive advantage of distinctive competence (see, e.g., Dos Santos and Peffers, 1995). The majority is more likely to seek shared competence and competitive parity.

Because firm competencies differ, any innovation presents different prospects to potential adopters. It is unlikely to be equally suitable to all, even within an industry. Those for whom it is most suitable are candidates to be the true innovators and early adopters (Tolbert and Zucker, 1983). For them, the 'know-why' associated with their prospective adoption decisions may be strategic and self-apparent. However, these firms face the difficulty that early on little is known about how to make the innovation successful. Later adopters, in contrast, can draw from the experiences of those who went before them. They can more easily tap the growing implementation 'know-how' in the broader community of users, vendors, and consultants. However, unless the innovation is adapted over time to their needs, and especially where earlier adopters report widespread problems, potential later adopters may increasingly question the innovation's suitability. Accordingly, any particular IT innovation may or may not be destined to 'sweep the industry.' How then, in these circumstances, do firms more specifically face the issues of whether, when, and how to make their innovation moves?

As already suggested, firms are understood to be purposeful in their pursuits (Ackoff and Emery, 1972). Firms set goals and objectives, and make business decisions under substantial uncertainties (Nelson and Winter, 1982). They typically espouse rationales, often packaged as 'business cases,' or *know-why*, for innovating with IT. Such know-why suggests business benefits to be obtained. In the context of purposeful action, this know-why incorporates, at least implicitly, reasoning about desirable strategic ends and how they might be accomplished. That is, know-why represents motivating *theory* for the firm's action.[2] As such, it serves not only to guide the innovative action as it unfolds, but may also be invoked to evaluate eventual outcomes.

Because firm competencies vary, so too may firm rationales for innovating with a particular IT.[3] True innovators and early adopters are more likely to espouse distinctive rationales. Later adopters can draw from the experience of those who went before them, and are more likely to borrow from the community's shared know-why, in crafting their own rationales. Adapting this shared know-why to the needs of the majority, and expressing this as part of an ongoing *organizing vision* for a particular innovation (Swanson and Ramiller, 1997), is an important community task, likely to be critical to the innovation's continued diffusion.

In this broad context, any one firm's success in innovating with IT may thus hinge on both its know-why for adoption and its know-how for implementation and assimilation. As suggested above, the timing of the firm's engagement with the innovation is especially important in this regard. The community's know-how and know-why for an innovation are under constant development and may at any time be more or less well articulated, more or less easy to tap. Similarly, the firm's own *readiness* for undertaking the innovation, in terms of its own know-how, culture, and needs (Chwelos *et al*., 2001), is likely to be changing and must be appraised and calibrated. Not surprisingly in this problematic context, firms will undertake a specific innovation, particularly a complex one, with varying degrees of success. In choosing to adopt an innovation, not all firms will bring the right know-why to the decision. Some will bring unrealistic expectations for the innovation; others may follow the herd for the vaguest of reasons. In implementing the innovation, not all will deploy the right know-how. In particular, where the know-why is wrong-headed, the right know-how may not be correctly ascertained in making the know-when decision, nor may it be subsequently fostered. In sum, the firm's innovation *reasoning* is likely to be important to the success it achieves from its undertaking. Figure 1 summarizes in the form of a simple explanatory success model.

Broadly, the model proposes a knowledge-based explanation for an innovation adopter's implementation success. Its novelty lies in its differentiation between a firm's know-how

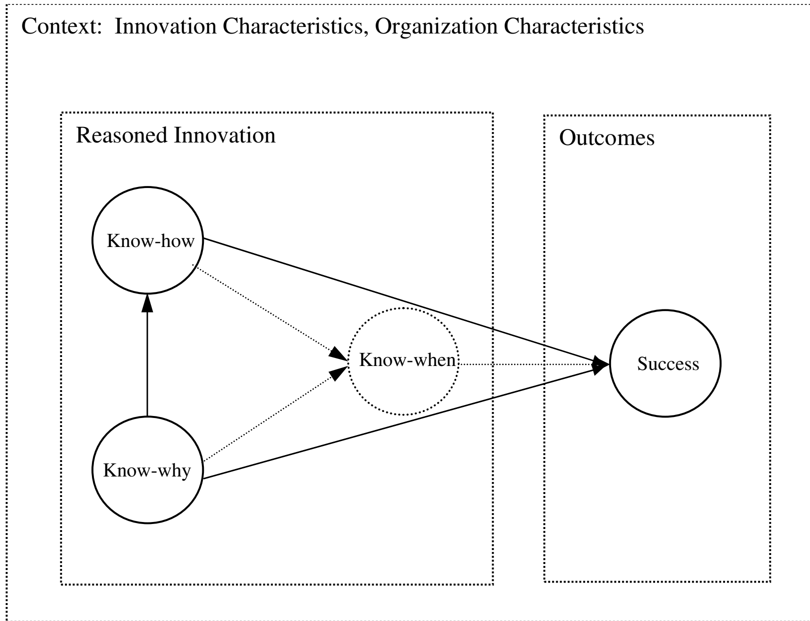

Figure 1 Reasoned Innovation Model. Specifications: (i) A firm's innovation reasoning will be composed principally of know-why (for adoption) and know-how (for implementation). Its know-how reasoning will be informed by its know-why. (ii) A firm's overall success with an innovation will depend substantially upon the know-why and know-how it brings to the undertaking. Assumptions: (i) Contextual variables will be reflected in a firm's innovation reasoning (and actions). (ii) A firm's know-when (for its actions) will be implied by its know-why and know-how.

and know-why for the innovation. In its present form, it makes several simplifying working assumptions. First, it assumes that the timing of the firm's engagement with the innovation, as reflected by its know-when, follows from its know-why and know-how, and makes no independent contribution to explaining success. Second, it assumes that firm characteristics and certain firm-innovation attributes, arising from the interaction of the firm and the innovation (Meyer and Goes, 1988), are reflected in the firm's know-why and know-how, and do not contribute to explaining success beyond this. These simplifying assumptions place a heavy explanatory burden on the model. We will reconsider them below in our analysis.

While the model applies broadly to innovating with IT, the present research addresses its explanatory applicability to innovating with packaged business software in the mid-to-late 1990s (Swanson, 2003). We briefly describe this context next.

Innovating with packaged business software

In the 1990s many firms turned to packaged business software when they replaced the older, often home-built systems in their application portfolios. Such replacement had become a priority for many, who felt increasingly burdened by their 'legacy systems.' They looked to ERP, a significant innovation in the packaged software market, which promised to relieve firms of their legacy system burdens.

The ERP vision offered an 'enterprise-wide view' of business software, aimed at facilitating internal integration of the technical and business core, as well as external integration with business customers (Wylie, 1990). With its roots in manufacturing, ERP was initially presented as a 'next-generation MRP II' (Keller, 1999), but as a concept it soon transcended industry boundaries. By 1995 the ERP movement was in full ascendance. Major vendors included SAP, Oracle, PeopleSoft, Baan, and J.D. Edwards. Leading consulting firms, such as Andersen Consulting, ICS Deloitte, and Price Waterhouse, were heavily engaged (Lieber, 1995: 122–123). In the mid-to-late 1990s, ERP adoptions increased rapidly. As the new millennium approached and the infamous Y2K problem achieved wide public recognition, firms found still another compelling reason to move to ERP. By the end of the decade, about half the larger US and European companies had reportedly made the move (Cap Gemini Ernst & Young, 1999). Many of these were, however, still engaged in their multi-year implementations.

Summarizing, the 1990s were marked by what may be termed the *package transition* in the employment of business application software (Swanson, 2003). While packaged business software had already long been in use, it was in the 1990s with the advent of ERP that it began to dominate enterprise decisions throughout the world. It is in this context, then, that we ask: how did a firm's know-why for adoption and know-how for implementation contribute to its success in innovating with packaged business software in the 1990s?

From our model, successful innovation with ERP should hinge on having both the right implementation know-how and the right adoption know-why. Moreover, as the decision to adopt logically precedes the choice of an implementation approach, having the right adoption know-why should help in acquiring or fostering the right implementation know-how. But, more specifically, what components of know-why and know-how should be the more important ones to achieving success? The answer to this question would likely be specific to ERP and the progress of its diffusion in the broader community. In the research described next, we thus aimed to explore the general viability of our model, as well as its knowledge particulars for the case of ERP.

Research method

Undertaking a survey

In the summer of 1998, we began a multi-year mail survey to assess how and why firms were successful or not as they attempted to make the package transition. Working with our own substantial US-based CIO mailing list, we administered the survey in three waves, the first in the late summer 1998, the second in the fall 1999, and the third in the fall 2000. By spreading the survey over several years, we sought to be sensitive to what might be a changing success story.

Because our CIO mailing list was and still is peculiar to us (it is for instance biased toward our geographical location and toward larger firms with past interactions with us) we did not seek a randomly ‘representative’ respondent sample from it. Rather, we simply aimed for a respondent sample large and heterogeneous enough in its composition (across industries, for example) to suggest some likely external validity to our findings.

In the survey, we asked prospective respondents to report on their recent adoption and implementation of a business application package of significant importance to their firm or one of its divisions. We did not restrict respondents to ERP as it has been variously defined. However, our cover letter highlighted our interest in learning about the adoption of packages offered by major ERP vendors.

The questionnaire itself had three parts.[4] The first solicited basic background data on the enterprise. The second part sought certain factual data on the adoption and implementation of a selected package. The third part requested the CIO’s assessment of the adoption and implementation experience, and included 55 judgmental statements, with each of which the respondent could simply agree or disagree on a five-point scale (scored from ‘strongly agree’ = 1 to ‘strongly disagree’ = 5). Drawn from our own reading of the practitioner literature on ERP, the statements addressed a range of knowledge-related issues spanning both forms of knowledge and types of organizational participants. A total of 28 statements provided in our judgment indicators of adoption know-why; 23 others provided indicators of implementation know-how; four provided indicators of related success. The statements also tapped the contributions of various stakeholders, including IS staff, users, top management, consultants, and vendors.[5]

The questionnaire was pre-tested with two firms for clarity and ease of completion before being sent out to the mailing list. From the three mailing waves, we received 121 responses from a wide variety of firms. Among these firms, one had not yet completed the adoption process. Two had adopted a package, but did not provide assessment data. Hence, our analysis was based on responses from the remaining 118 respondents, who have all implemented their systems and provided assessment data. We tested for significant differences in answers from the three waves, and finding none, we pooled the responses in our analysis.[6]

Respondent sample

From the respondents’ answers to the first part of the questionnaire, we can broadly describe our sample. Our 118 respondents came from 24 different industries. Manufacturing (15%), financial services (10%), utilities and power (9%), and health care (8%) constituted the largest segments. In terms of size, respondents varied substantially in terms of their total number of employees: the median number was 5000 and the quartile range was 1550–15000. The number of IS employees similarly varied: the median number was 140 and the quartile range was 32–400. To provide baseline information on their application portfolios, we asked our respondents to tell us their current percentage of custom-developed (as opposed to packaged) applications. The median reported custom application percentage was 40% and the quartile range was 10–70%.

We asked ourselves how our sample compared in its known characteristics to broader populations, for example, the Fortune 1000 companies. We found from one exploratory comparison that while our sample was diverse, it may be over-represented in several industrial categories, in particular, in manufacturing, and metals and natural resources.[7] Still, we concluded that the respondent sample was large and diverse enough to warrant analysis and to suggest some external validity to our findings, as long as we were cautious about response-bias and the population to which we would generalize. We speak further to this issue below.

Organizational innovation context

Next, we examined the factual data reported by our respondents on the adoption and implementation of a selected software package (from the second part of the questionnaire). This provides important context on the organizational innovation for the analysis of our basic success model. For each respondent’s package, the factual data include: the package vendor, the package adoption date, number of implementation sites, first and completed implementation dates, number of support staff, number of daily users, and total number of users. Table 1 summarizes these data for our respondents.

From Table 1 we see that the leading ERP vendors provide the substantial majority of the packages adopted by our respondents, consistent with expectations. The time frame for adoption has a quartile range from September 1995 to April 1998, roughly coincident with the peak period of ERP adoption in the US (Keller, 1999; Eschinger, 2002). For initial implementation, the comparable time frame is from October 1996 to January 1999, while for completed implementation it is from August 1998 to January 2000. Taken together, these data suggest that later adopters implemented over shorter time periods, consistent with the idea that the community’s implementation know-how increased over these years. However, time of adoption proved to be unrelated to our respondents’ success, as might be expected if later adopters also tended to benefit less from the innovation than did earlier adopters, thus giving no relative cost/benefit advantage to either earlier or

Table 1 Descriptive statistics on organizations and package adoption

Variable	*Median*	*Quartile range*
Organization		
Number of full-time employees	5000	1550–15000
Number of IS employees	140	32–400
Custom apps (percent of total)	40%	10%–70%
Adoption and Implementation		
Adoption date	Feb.'97	Sep.'95–Apr.'98
Number of implementation sites	2	1–12
Initial implementation date	May'98	Oct.'96–Jan.'99
Implementation completion date	Jul.'99	Aug.'98–Jan.'00
Number of support staff	15	5–40
Number of daily users	75	25–300
Total number of users	170	40–800
Package vendor	*Percent of all packages*	
PeopleSoft	27%	
SAP	16%	
Oracle	14%	
JD Edwards	8%	
Baan	5%	
Other	30%	

later adopters. Being unrelated to success, time of adoption, reflective of the firm's know-when, was dropped from further analytic consideration, consistent with the assumptions of our success model (Figure 1).

Other contextual variables from Table 1 were similarly found to be uncorrelated on the whole with innovation success. Among these were: the scale of the organizational innovation, as reflected by the number of implementation sites, and the numbers of support staff and users, and organization size, as reflected by the numbers of total and IS employees. Nor were these variables correlated on the whole with adoption know-why and implementation know-how, somewhat to our surprise.[8] We thus dropped these variables from further analytic consideration, again consistent with the assumptions of our success model. From our factual data, neither organizational innovation characteristics nor firm characteristics appear to explain the firm's relative success with packaged business software.

Success model analysis

Finally, we examined the judgmental statement data pertinent to our research model, using multivariate methods. We first performed an exploratory factor analysis of the statement items to identify component factors *within* each of the three model constructs: know-why, know-how, and success. Largely consistent with the groups of issues and stakeholders associated with our formulation of the statements as described above, three know-why factors, four know-how factors, and one success factor were identified for further analysis.[9] For each of these factors, we selected two or three items with the highest loadings as factor indicators. Table 2 lists the factors and their selected indicators (18 in all) that we would examine further. The three know-why factors are seen from their associated statements to characterize adoption rationales based in what we term *business coordination*, *application integration*, and *external authority*. The four know-how factors are seen from their associated statements to characterize what we term *vendor support*, *project planning*, *management understanding*, and *custom requirements* capabilities.

We next assessed the reliability of the selected items for each factor, using Cronbach's coefficient alpha (Cronbach, 1951). Seven of the eight alphas were above the conventional threshold 0.70 (Nunnally, 1978), excepting that for the factor *external authority*. We thus dropped external authority and its two indicators, retaining the other seven factors and their 16 indicators for subsequent analysis.

We then re-examined the validity of the selected statement items, this time *across* the three model constructs with a principal component factor analysis. Table 3 shows that the seven factors extract nearly 77% of the variance. All the items of each factor load with high coefficients on the factor that they are intended to indicate, suggesting good convergent validity. The loadings are low on other factors that the items are not intended to indicate, suggesting good discriminant validity. On the whole, Table 3 shows a good loading pattern.

To achieve our research objective – to explore the validity of our research model and identify the know-why and know-how component factors that best explain success – we next specified a series of structural equation models (SEM). The SEM approach is particularly appropriate to our purposes, as it provides substantial flexibility to model relationships among multiple predictor and criterion variables and to construct unobservable latent variables (Chin, 1998). Although used most often to test *a priori* theoretical assumptions against empirical data for *confirmatory* purposes (Fabrigar *et al*., 1999), SEM's uses are in fact much broader. In conjunction with exploratory factor analysis, fitting multiple competing models with latent factors to the same data constitutes a logical progression in *exploratory* modeling (Mulaik and Millsap, 2000; see, e.g., Carroll (2003) for a recent example). Comparing the relative fit of multiple models (as in this research) supports the specification of theoretical models for future confirmatory studies.[10]

The series of SEM models was chosen with the limitations imposed by our 118-case and 16-variable data in mind. We sought to identify a minimally complex model that could substantially explain success. Thus, each model in the first and principal series includes one know-why factor, one know-how factor, and the success factor. The two know-why factors and four know-how factors are variously combined to generate eight models (labeled A–H) in total, as displayed in Table 4. For instance, Model C consists of one know-why factor (business coordination) and its indicators (Items 2 and 46), one know-how factor (management understanding) and its indicators (Items 35 and 39), and the success factor and its indicators (Items 24, 33, and 55). We assessed each model with our data using

Table 2 Factor and indicators

Factor	*Item no.*	*Judgmental statement in questionnaire*
Know-why		
Business coordination	2	This package provides features which enable us to work better with our suppliers and/or customers.
	46	This package facilitates our user communications across departments.
Application integration	7	This package enables us to bridge easily to other applications in our portfolio.
	23	An advantage of this package is that it works with other packages from other vendors.
External authority	29	This package was initially evaluated and recommended to us by a consultant.
	48	Adoption of this package is a step toward outsourcing our IS department.
Know-how		
Vendor support	9	This package is well maintained by the vendor.
	14	This package is relatively free of bugs.
Project planning	6[a]	We underestimated the amount of training needed to implement this package.
	13[a]	We underestimated the amount of consulting we required to implement this package.
	25[a]	We underestimated the time it would take us to implement this package.
Management understanding	35	Top management has provided us with the necessary resources to successfully implement this package.
	39	Our top management understands the costs to implement and maintain this package.
Custom requirements	4[a]	We underestimated the amount of customization needed for this package.
	47[a]	This package requires enhancements in order to better meet our needs.
Success	24	Most of our users of this package are on the whole happy with it.
	33	We are on track with our plans for the implementation and use of this package.
	55	On the whole, our implementation of this package has been successful.

[a]Reverse coded.

Table 3 Factorial validity of indicators

	Success	*Project planning*	*Vendor support*	*Custom requirement*	*Application integration*	*Business coordination*	*Management understanding*	*Communality*
I24	**0.79**	0.32	0.38	0.24	0.30	0.48	0.04	0.71
I33	**0.80**	0.20	0.21	0.33	0.23	0.16	0.28	0.68
I55	**0.76**	0.22	0.41	0.22	0.10	0.30	0.14	0.63
I6	0.04	**0.83**	0.18	0.15	0.05	0.25	0.33	0.79
I13	0.25	**0.85**	0.37	0.35	0.13	0.23	0.19	0.73
I25	0.44	**0.81**	0.28	0.37	0.30	0.06	0.15	0.76
I9	0.49	0.34	**0.82**	0.42	0.25	0.39	0.24	0.76
I14	0.30	0.29	**0.89**	0.31	0.08	0.11	0.06	0.84
I4	0.29	0.48	0.43	**0.87**	0.10	0.11	0.19	0.81
I47	0.28	0.21	0.28	**0.92**	0.14	0.20	0.19	0.88
I7	0.19	0.12	0.08	0.11	**0.88**	0.07	0.03	0.79
I23	0.24	0.18	0.15	0.11	**0.88**	0.09	−0.05	0.78
I2	0.50	0.35	0.37	0.20	0.16	**0.73**	−0.12	0.68
I46	0.24	0.16	0.13	0.14	0.06	**0.89**	0.17	0.83
I35	0.46	0.23	−0.06	0.18	0.01	0.05	**0.79**	0.81
I39	0.12	0.36	0.39	0.30	0.09	0.21	**0.80**	0.78
Eigenvalue	4.75	1.70	1.49	1.29	1.17	1.00	0.86	
Variance	29.67	10.60	9.34	8.09	7.31	6.23	5.35	Total = 76.58%

Extraction method: Principal component analysis.
Rotation method: Promax with Kaiser Normalization.

EQS (Bentler and Wu, 2000), a package specifically developed to provide tools for SEM in the context of the Bentler–Weeks framework (Bentler and Weeks, 1980). For each model, the ratio of cases to variables and the ratio of cases to estimated parameters were acceptable. No systematic pattern was identified for the few missing data points. Normality of all 16 variables was assessed through examination of histograms and Q–Q plots. Standard indicators showed that none of the variables was significantly skewed or highly kurtotic. Additionally, the normalized Mardia's coefficient for each model and the Malahanobis distance for each observation suggested no apparent deviation from multivariate normality in our data. Accordingly, we used the conventional maximum likelihood estimation method in EQS.

Finally, we compared the best of our models in this principal SEM series, to alternative similarly assessed models employing either two know-why factors alone, or two know-how factors alone, in explaining implementation success. We report the results below.

Findings

Table 5 shows the descriptive statistics associated with the 16 judgmental variables together with their correlations. Particularly noteworthy are the three variables (24, 33, 55) used to measure the latent success construct. The relatively low values of their means (2.40, 1.87, and 1.97) indicate that our respondents have as a whole been successful with their packaged business software innovations. While this is encouraging by itself, it suggests too that we should be wary of response bias in our sample. We note in particular that outright failures in implementation, where the project was abandoned, are excluded from our sample by its nature. Our 118 respondents have all implemented their packages, at least in first part.

With regard to the correlations among the 16 indicators, we observe that 52 are significant at the 0.01 level and another 27 are significant at the 0.05 level. The 10 largest correlations range from 0.50 to 0.62; nine of these are between indicators of the same factor, while one is between an indicator (#2) of business coordination and an indicator (#24) of success. Overall, a rich mix of modest but significant correlations between indicators of different factors is seen, consistent with expectations that the factors are related.

In our principal series of structural equation models, all eight converged without problems. Table 6 summarizes the standardized estimation results and goodness-of-fit for these models. The model χ^2 values and fit indices show that Models C, D, E, and H are good-fitting models by most criteria, such as the χ^2 test, the Bentler–Bonett non-normed fit index (Anderson and Gerbing, 1984), the comparative fit index (CFI) (Hu and Bentler, 1999), and the

Table 4 Composition of analysis models

		Know-how			
		Vendor support	*Project planning*	*Management understanding*	*Custom requirements*
	Item number	*9,14*	*6,13,25*	*35,39*	*4,47*
Know-why					
Business coordination	2,46	A	B	C	D
Application integration	7,23	E	F	G	H

Table 5 Descriptive statistics and correlations

	Mean	*Std. Dev.*	*N*	*2*	*4*	*6*	*7*	*9*	*13*	*14*	*23*	*24*	*25*	*33*	*35*	*39*	*46*	*47*	*55*
Item 2	2.03	0.86	118	1.00															
Item 4	3.15	1.40	118	0.24**	1.00														
Item 6	3.31	1.24	118	0.14	0.28**	1.00													
Item 7	2.68	1.00	116	0.11	0.08	0.03	1.00												
Item 9	2.49	1.17	118	0.38**	0.43**	0.19*	0.19*	1.00											
Item 13	3.36	1.31	118	0.32**	0.40**	0.57	0.07	0.32**	1.00										
Item 14	2.97	1.18	118	0.24*	0.34**	0.15	0.05	0.60**	0.23*	1.00									
Item 23	2.65	1.03	118	0.19*	0.12	0.07	0.58**	0.24*	0.11	0.12	1.00								
Item 24	2.40	0.91	117	0.51**	0.20*	0.12	0.17	0.46**	0.18	0.27**	0.31**	1.00							
Item 25	3.47	1.29	118	0.23*	0.43**	0.50**	0.22*	0.31**	0.56**	0.28**	0.22*	0.40**	1.00						
Item 33	1.87	1.00	117	0.28**	0.22*	0.05	0.20*	0.38**	0.18	0.23*	0.13	0.44**	0.28**	1.00					
Item 35	2.03	1.08	118	0.13	0.20*	0.20*	0.04	0.23*	0.14	0.04	0.06	0.26**	0.26**	0.41**	1.00				
Item 39	2.49	1.33	118	0.15	0.28**	0.31**	0.09	0.34**	0.30**	0.24**	0.07	0.23*	0.23*	0.19*	0.55**	1.00			
Item 46	2.41	1.02	118	0.56**	0.11	0.23*	0.10	0.29**	0.08	0.07	0.09	0.34**	0.08	0.19*	0.17	0.17	1.00		
Item 47	3.64	1.19	118	0.18*	0.62**	0.07	0.09	0.34**	0.24**	0.21*	0.10	0.29**	0.25**	0.31**	0.16	0.30**	0.18	1.00	
Item 55	1.97	0.97	118	0.32**	0.27**	0.09	0.11	0.42**	0.24**	0.29**	0.09	0.58**	0.20*	0.45**	0.25**	0.23*	0.21*	0.20*	1.00

*$P<0.05$; **$P<0.01$.

root-mean-square error of approximation (RMSEA) (Browne and Cudeck, 1993; Hu and Bentler, 1999). The fit for the other models, while not as good, is marginally acceptable.

The values of R^2 indicate that Model C explains the most variance (59%) in success. Shown in Figure 2, Model C is our best model by both model-fit and R^2 criteria. It is composed of the business coordination know-why factor and the management understanding know-how factor, *both* of which are significant in explaining implementation success. The coefficient for the path linking business coordination to management understanding is positive, but not significant. Examining the estimated path coefficients across all our models, we found that the business coordination factor (Models A–D), the vendor support

Table 6 SEM standardized estimation and model fit summary

		Model							
	Item No.	*A*	*B*	*C*	*D*	*E*	*F*	*G*	*H*
Know-how→Success									
Vendor support	9, 14	0.47*				0.55*			
Project planning	6, 13, 25		0.11				0.34*		
Management understanding	35,39			0.37*				0.50*	
Custom requirements	4,47				0.21				0.38*
Know-why→Success									
Business coordination	2,46	0.51*	0.63*	0.59*	0.61*				
Application integration	7,23					0.18	0.24	0.29*	0.25*
Know-why→Know-how		NA	0.42*	0.24	0.32*	0.24*	0.22	0.05	0.15
R^2 for success		0.48	0.46	0.59	0.51	0.38	0.21	0.35	0.24
Model parameters									
Independence χ^2		231.81	288.02	183.53	218.58	228.70	272.39	184.29	213.49
Degrees of freedom		21	28	21	21	21	28	21	21
Model χ^2		28.18	41.45	14.65	15.16	10.84	34.76	19.97	15.41
Degrees of freedom		12	17	11	11	11	17	11	11
P-value		0.01	000	0.20	0.18	0.46	0.01	0.05	0.16
Bentler–Bonett non-normed fit index		0.87	0.85	0.96	0.96	1.00	0.87	0.90	0.96
Comparative fit index (CFI)		0.92	0.91	0.98	0.98	1.00	0.93	0.95	0.98
RMSEA		0.11	0.07	0.05	0.04	0.00	0.10	0.09	0.06
LISREL GFI		0.94	0.93	0.97	0.97	0.97	0.93	0.95	0.96
Number of iterations		7	7	7	7	6	7	7	7

*Significant at 0.05 level.

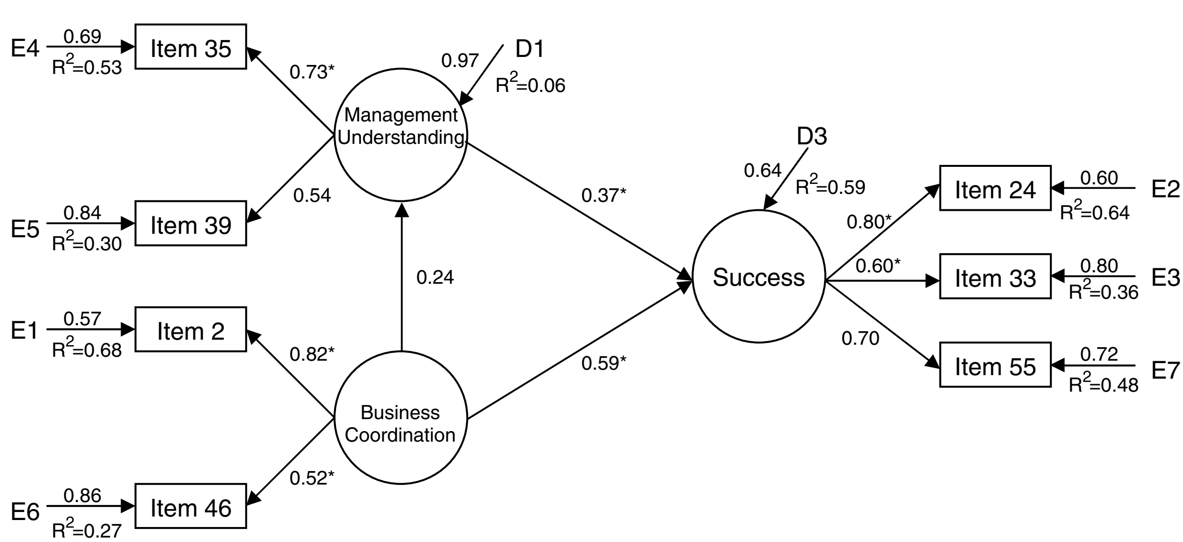

Figure 2 Diagram and estimation results for Model C.

factor (Models A and E), and the management understanding factor (Models C and G) are consistently significant in explaining implementation success.

With regard to other candidate factors, Models E–H suggest that the application integration factor is significantly associated with implementation success only when a know-how factor such as management understanding (Model G) or custom requirements (Model H) is present. The project planning and custom requirements factors are significant when the models include the application integration factor (Models F and H), but not when the models include the business coordination factor (Models B and D). Overall, three factors – vendor support, management understanding, and business coordination – are found to be better than others in explaining implementation success.

As mentioned above, we also assessed other models (not shown) consisting of know-why factors alone and know-how factors alone. Those models showed poorer fit with our data and explain less variance in success than did our best Model C.[11] Hence, overall, we find support for our theoretical conjecture that both the right adoption know-why and the right implementation know-how are important to successful implementation of packaged business software.

Still, the findings were not entirely consistent with the model. We also conjectured that having the right adoption know-why may help acquire or foster the right implementation know-how. While the significant paths from the know-why factor to the know-how factor in Models B, D, and E show marginal support, the paths linking know-why to know-how are not significant in the other five models, including our best one, Model C. The evidence for this conjecture is therefore limited.

Discussion

On the whole, our findings support the notion that adoption know-why and implementation know-how are jointly important to innovation success. That know-how is thus important is not surprising. From the literature, firms themselves may be theorized in these terms (Nelson and Winter, 1982). Thus, Kogut and Zander (1992: 383) argue 'The analysis of what organizations are should be grounded in what they know how to do.' Similarly, because an organization makes up a range of skills, its innovations too must be an outgrowth of its previously acquired know-how. Thus, Pennings and Harianto (1992: 358) say: 'If the innovation is too remote from the current skills, we would expect the innovation not to materialize, or at least not have a high success probability.' Accordingly, when firms engage in a particular innovation with IT, they must surely have the right know-how to build upon.

The finding that vendor support and management understanding are significant know-how factors in innovating successfully with packaged business software is consistent with both the practitioner and research literatures. Prior research has found that project success hinges on vendor package compatibility (Janson and Subramanian, 1996; Willcocks and Sykes, 2000). With ERP, the vendor also assumes much, although not all, of the maintenance responsibility, and new roles and responsibilities emerge, creating significant challenges (Hirt and Swanson, 2001). Additionally, the need for 'top management support' has long been singled out for its importance to information systems efforts more broadly (Swanson, 1988; Lucas *et al*., 1990; Gallivan, 2001; Robey *et al*., 2002). In the case of ERP, managerial understanding is likely to be particularly important in assembling the implementation team, choosing the project manager, attending to change management, and communicating change progress throughout the enterprise (Bancroft *et al*., 1998: Chapter 6).

The actual achievement of management understanding necessary to innovating successfully with ERP is likely to be a subtle accomplishment. From the item indicators, we see that this understanding is likely anchored in expectations of implementation resources and costs. Such expectations are set when the package is justified for adoption and the resource commitment is first made. From the literature, we know that many firms suffered substantial cost and schedule overruns in their ERP implementations in the 1990s (Davenport, 1998). Many executives faced significant resource demands that had not been foreseen. Those whose expectations were more realistically set to begin with, or whose expectations proved to be more adaptable when it turned out to be necessary, became through their understanding important contributors to ERP success.

Overall, the other candidate know-how factors – project planning and custom requirements – are dominated by management understanding and vendor support in explaining success in innovating with packaged business software. We interpret this to mean that management understanding and vendor support are the most indispensable of the know-how factors. Thus, for example, while failures in project planning can sometimes be overcome by management understanding, the stubborn absence of management understanding cannot be overcome by good project planning. Good estimates of resource requirements hardly matter where the resources are in any event inadequately provisioned. Too, although lack of project planning and customization skills may sometimes be ameliorated by vendor support, the reverse is unlikely to be the case. Only where the package code is acquired for the purpose of taking full ownership of it, a relatively rare circumstance with ERP, may ongoing vendor support not be crucial. Adding to the challenge, in a rapidly expanding market such as that for ERP in the 1990s, the vendors' support resources can be stretched thin.

Apart from such know-how, that know-why is important to innovation success is a novel finding to our knowledge. Most research to date finds success explainable by generalized contextual factors, such as organizational size (Fuller and Swanson, 1992; Rogers, 1995: 379) or industry (Pavitt, 1984; Klevorick *et al*., 1995), in conjunction with generalized human agency factors, such as top management support and championship (Leonard-Barton and Deschamps, 1988; Damanpour, 1991). That know-why, or what might be termed *strategic reasoning*, should be important to success seems obvious enough, but has been little explored in empirical studies, to our knowledge.[12] Yet because such strategic reasoning can be problematic, especially where innovations are complex, it deserves more attention in explaining outcomes.

That business coordination proves to be a significant know-why factor in innovating successfully with packaged business software in the 1990s is an important finding. First and foremost, it reminds us that know-how by itself may not suffice, where an innovation is adopted for the 'wrong' reasons. It underscores the importance to management of attending carefully to the adoption rationales for their innovations, by seeking to distinguish between likely and unlikely claims made on the innovation's behalf, in particular. It suggests that executives should be particularly wary of broad claims such as prospective cost reductions that can be easily translated into return-on-investment justifications, but that may represent wishful thinking more than substantiated and reasoned judgment.

Secondly, we are reminded that business benefits are likely to be the surest footing on which to construct and articulate the firm's know-why, in innovating with IT. In the case of ERP packages, business coordination speaks relatively directly to business benefits. The other candidate know-why factor in our models does not. Application integration may constitute an important technical achievement, but it does not by itself directly improve the business. It is silent as to whether the business itself will be changed in any way.

Limitations

The present research has several limitations that bear upon the likely validity of its findings. First, the survey method allows us to gather data with face validity as indicators of know-how and know-why, in addition to success, but these data do not come directly from the firms' adoption and implementation processes themselves. We have made no direct observations of these processes with which to buttress our findings. Moreover, the survey items themselves are not worded so as to be unambiguously associated with either know-how or know-why, and our categorization of them is admittedly provisional, warranted only in the present exploratory context. Our basic instrumentation in this research was rudimentary.

Second, we rely on CIO assessments for our judgmental data, which may or may not be in accord with assessments that might have been made by others, such as, for example, user executives. We also rely on the judgment of a single informant, rather than on multiple informants from each firm. Third, as already mentioned, our respondents represent firms that have been relatively successful in innovating with packaged business software. Those firms that have failed outright in their implementations were not among our sample.

Lastly, as a reminder, we have explored our model in the single context of innovating with packaged business software in the 1990s. This is clearly a singular, historically situated case. It remains to validate the model's applicability to other innovations in other historical contexts.

Conclusion

In summary, our findings are suggestive of additional research to be undertaken, more than they are conclusive in answering our basic research question. Is adoption know-why important to success in innovating with IT, and if so, how and to what extent is it important, and in what circumstances? In the present paper, we have only begun to probe the answers to this question.

Still, the research reported here makes several significant contributions. First, it offers a parsimonious model that opens up the 'black box' of the firm's reasoning process in explaining the firm's innovation moves and accomplishments. In the context of innovating with packaged business software, it finds in an exploratory way that the model has substantial power to explain relative implementation success among firms. This breaks new ground as a means to tell as well as to validate the 'success stories' associated with various IT innovations.

Second, we add to the growing research literature on ERP adoption and implementation (see, e.g., Willcocks and Sykes, 2000; Scott and Vessey, 2002; Markus *et al*., 2003) with our finding that the adoption know-why factor *business coordination* has been important to explaining relative implementation success achieved. Among the various rationales for adopting ERP, this proves to be the strongest one among our respondents. Thus, we validate this rationale for practitioners seeking guidance. We add to prior research suggesting that making a strong business case for ERP is important not only in deciding upon adoption, but also in monitoring post-implementation performance (Ross *et al*., 2003). Too, we reconfirm the importance of *management understanding* and *vendor support* as important know-how factors for achieving success in this domain, in particular.

Future research must of course further explore and validate our knowledge-based success model. From studies similar to ours, we are especially interested to know whether the model's validity extends to innovations other than packaged enterprise software, and if so, how the knowledge components might differ or be the same. We are interested to uncover the different 'success stories' that might accordingly be told, and to learn how these might be the same or different from everyday practitioner wisdom. We are also interested to know whether or not these success stories are stable over time, or whether they are largely the momentary products of historical processes.

Researchers might also undertake two complementary types of studies: organizational case studies and innovation case studies. Organizational case studies could examine in depth how a particular firm goes about comprehending, adopting, implementing, and assimilating an IT innovation. They could probe both the know-why brought to bear on adoption, and the know-how brought to bear on implementation and assimilation, as well as the interplay between both forms of knowledge. Comparative case studies might examine how this know-why and know-how varies according to differences among both firms and innovations.

Innovation case studies could examine in depth how a particular innovation is comprehended, adopted, implemented, and assimilated among a population of organizations over the course of its history. Such studies could probe both the community's know-why and its know-how in terms of how they shape the innovation's diffusion. They might pay particular attention to whether and how the innovation becomes a management fashion (Abrahamson and Fairchild, 1999), and whether and how this affects the community's know-why and know-how, and with what consequences. Where an innovation becomes highly fashionable, many will flock to it, of course, but the attention firms give to their own strategic reasoning, as differentiated from that of others, may be weakened.

Lastly, from our research, practitioners are encouraged to pay more analytical attention to the know-why associated with their innovations with IT. Traditionally, practitioners have focused on the one-time justification of their innovation initiatives. In particular, they have sought ways to jump or circumvent the financial hurdles erected for their proposed investments. They have arguably given less attention to the lasting quality of their strategic know-why reasoning, than they have to the metrics of the investment moment. Where innovating with IT is concerned, firms deserve better.

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Notes

1 Laggards are slow to adopt, relative to the majority. Still others may never adopt the innovation. Rogers' classification scheme and percentages presume a (roughly) normal distribution of adopters over time of adoption. The majority adopts within one standard deviation from the mean time of adoption.

2 See Garud (1997) for a discussion of know-why as that which articulates the principles underlying a technology. Our own concept of know-why, tied to purposeful action, is broader than Garud's. The principles underlying a technology might be important to know-why for innovating with IT, as we would understand it, but they would not be sufficient.

3 Indeed, following Nelson and Winter (1982), firms may have different strategic capabilities for determining their know-why for innovating with IT. Some may go about it much more effectively than others. Some may have an established strategic planning process that brings together the best thinking of organizational members, for instance.

4 A copy of the questionnaire is available from the authors.

5 The diversity of the 55 judgmental statements reflected our exploratory purposes. While the statements are substantial in number, they are not necessarily complete, with regard to the knowledge-related issues that might have been included.

6 We recorded the date when each response was received by a continuous variable called 'reporting date.' We found no statistically significant correlation between reporting date and any other variable measured in this study. Further, we included the reporting date variable as a predictor of the success factor in our structural equation models, as described later. Inclusion of reporting date did not significantly change the estimation of any model. Nor was reporting date a significant predictor of success in any case. Therefore, it was appropriate to pool data from the three waves.

7 To make this comparison, we employed data from *InformationWeek* on ERP penetration by industry and then used these data to weight industry representation within the Fortune 1000. Overall, these data suggest that ERP has penetrated 69.5% of the Fortune 1000. These firms were then compared to our sample's industry representation.

8 We computed 176 correlations between 11 contextual variables (both firm characteristics and organizational innovation characteristics) and 16 indicators that enter into our success model, as described below. Only 10 of these correlations were significant at the 0.05 level, not significantly different from what might be expected by chance alone.

9 Our decision on how many and what factors to retain was based on several criteria suggested by Johnson and Wichern (2002): the amount of variance explained, the relative sizes of the eigenvalues, and the interpretability of each factor.

10 Because multiple models were fitted to the same data, the probability of obtaining spuriously significant fit for *each particular* model is multiplied. Nonetheless, the relative fit of various models can still be validly compared for exploratory modeling.

11 The best of these alternative models incorporated two know-why factors, business coordination and application integration, to explain 51% of the variance in success. Of the alternative models incorporating two know-how factors, the best one, which incorporated management understanding and vendor support, explained only 43% of the variance in success.

12 Oliver and Romm (2002) employ critical theory to examine ERP justifications in eight universities, exploring issues of domination, as opposed to implementation success. This suggests other theoretical bases for studying strategic reasoning.

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