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How does organisational absorptive capacity matter in the assimilation of enterprise information systems?

Nilesh Saraf,* Huigang Liang,† Yajiong Xue‡ & Qing Hu§

*Management Information Systems, Simon Fraser University, Burnaby, British Columbia, Canada, email: nsaraf@sfu.ca, East Carolina University, Greenville, North Carolina, USA, email: †liangh@ecu.edu, ‡xuey@ecu.edu, and §Supply Chain and Information Systems, College of Business, Iowa State University, Ames, Iowa 50011, USA, email: qinghu@iastate.edu

Abstract. *Extant literature offers two mostly distinct perspectives on enterprise systems assimilation – driven either by internal expertise and learning capability or by external institutional pressures. This study combines the two perspectives and subscribes to the view that organisations' learning capability moderates their acquiescence to institutional pressures. The study then anchors organisational learning capability to the concept of absorptive capacity and proposes that its two dimensions – potential absorptive capacity (PACAP) and realised absorptive capacity (RACAP) – affect enterprise systems assimilation through different pathways. Our survey-based empirical study of Enterprise Resource Planning (ERP) systems in the post-implementation stage reveals that while both PACAP and RACAP have a positive direct impact on assimilation, PACAP positively moderates the impact of mimetic (institutional) pressures, but not normative (institutional) pressures, on assimilation; whereas RACAP positively moderates the impact of normative pressures, but not mimetic pressures, on assimilation. Thus, our theoretical contribution lies in understanding the distinct ways in which PACAP and RACAP moderate the influence of external institutional pressures on enterprise systems assimilation.*

Keywords: IT assimilation, enterprise systems, ERP assimilation, institutional influences, absorptive capacity, organisational learning

INTRODUCTION

There is a clear recognition in the academic literature of the complexity involved in the assimilation of new information technology (IT), particularly large scale enterprise systems, into business operations. The adoption of such systems is only the beginning of an extended effort

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to derive the potential benefits of these systems (Markus & Tanis, 2000). Prior literature identifies a variety of critical success factors and theories that lead to a better assimilation of enterprise systems (Fichman, 2000; Purvis *et al*., 2001; Mustonen-Ollila & Lyytinen, 2003; Liang *et al*., 2007; Osei-Bryson *et al*., 2008).

This study furthers our understanding of the role of external institutional forces in the assimilation of enterprise systems within organisations. While recent studies stress the significant role of institutional pressures during IT adoption and assimilation (Teo *et al*., 2003b; Gosain, 2004; Liang *et al*., 2007), others have also emphasised the importance of firms' learning capabilities, which have figured prominently in IT assimilation studies (Cooper & Zmud, 1990; Attewell, 1992; Fichman & Kemerer, 1997; Armstrong & Sambamurthy, 1999; Robey *et al*., 2002; Teo *et al*., 2003a; Ravichandran, 2005). Thus, while we are mindful of the learning perspective in studies of post-implementation issues, we attempt to reconcile this perspective with the role of institutional forces that have been shown to be significant during this stage (Liang *et al*., 2007). Therefore, our research question is: In the assimilation stage of enterprise systems, how do the learning capabilities of an organisation affect the relationship between external institutional pressures and the degree of assimilation?

To capture the learning capabilities of an organisation, we use the two-dimensional operationalisation of absorptive capacity (ACAP) – Potential Absorptive Capacity (PACAP) and Realised Absorptive Capacity (RACAP) (Zahra & George, 2002). Our core thesis is that even though external institutional pressures can be considered as driving the diffusion of complex enterprise systems, absorptive capacity of organisations tempers or augments the impact of external pressures and thus grounds the IT innovations in organisation-specific contexts. Our results highlight the significant role of PACAP on assimilation, and suggest that cultivating high levels of PACAP can narrow the assimilation gap not only directly but also indirectly by moderating the effect of mimetic pressures on Enterprise Resource Planning (ERP) assimilation. Similarly, the importance of RACAP is highlighted because it augments the beneficial effect of normative pressures on ERP assimilation. We theorise and test the distinct ways in which these moderating effects can dominate one another depending on whether they are facilitating mimetic or normative influences.

The paper is structured as follows. In the following section we clarify the notions of ERP assimilation and organisational learning in the context of this study. Then we develop a research model to understand how institutional pressures and ACAP interact to influence ERP assimilation. This is followed by discussions on the survey instrument, data collection and results. We then examine the theoretical and practical implications of the findings, as well as limitations and future research.

THEORY AND HYPOTHESES DEVELOPMENT

Learning challenges facing ERP assimilation

In this study, we adopt the definition of assimilation by Purvis *et al*. (2001) as 'the extent to which the use of technology diffuses across the organizational projects or work processes and

becomes routinized in the activities of those projects and processes'. In developing the learning perspective of innovation assimilation, Attewell (1992) asserts that the knowledge required by organisations to use complex technologies is difficult to transfer and thus is acquired slowly as against other simpler technologies. A multitude of learning challenges arise in the assimilation phase as the system is rolled out to the end users. Because an ERP system is at its core a transaction processing system that underlies the internal business processes, it creates significant business process interdependencies (Gattiker & Goodhue, 2005; El Amrani *et al*., 2006). By virtue of the common data and process models underlying an ERP system, business-level data, which may be captured at one point in a process, is often used at multiple other points. This requires most users to understand the consequences of their actions on the workflow across interdependent units (El Amrani *et al*., 2006; Häkkinen & Hilmola, 2008). Baskerville *et al*. (2000) describe how users could adapt to a new ERP system better when they were able to expand their business knowledge about other functional domains. This and other studies show that the users must comprehend how the ERP system modules trigger tasks in other parts of the organisation and how the quality of data entered at one subunit affects decisions in other subunits (Robey *et al*., 2002; Jones & Price, 2004). Without such knowledge, the users are limited in solving coordination problems (Kim *et al*., 2005) and thus are more likely to resort to inventing workarounds or retaining legacy systems in parallel.

Absorptive capacity of organisations

The literature on ACAP is consistent with the learning perspective (Lichtenthaler, 2009). ACAP connotes a bundle of capabilities that enable an enterprise to recognise the value of new information, assimilate it and then apply it commercially (Cohen & Levinthal, 1990). Cohen and Levinthal suggest that inward-looking and outward-looking absorptive capacities together are essential towards successful exploitation of an innovation. More recent research has identified four mechanisms that either characterise or underlie an organisation's ACAP, namely, acquisition of external knowledge, absorption, transformation and exploitation (Zahra & George, 2002; Jansen *et al*., 2005; Todorova & Durisin, 2007). Given the prolonged nature of the assimilation phase of complex systems, literature suggests that, depending on the context, all of these four sets of routines should be active (Attewell, 1992; Massey *et al*., 2001). In the following discussion, however, we do not consider transformation routines as active during ERP assimilation, primarily because an ERP system does not change the fundamental nature of the product or service offered by an organisation. The transformation dimension is more relevant instead to studies that directly examine the relationship between ACAP and product–market competitiveness (Jansen *et al*., 2005).

The IT assimilation literature suggests that learning-based theories and models have great potential to explain success in using and exploiting new IT systems (Cooper & Zmud, 1990). Studies on IT assimilation have examined learning-based constructs in various ways to account for the difference in knowledge barriers faced by organisations (Boynton *et al*., 1994; Armstrong & Sambamurthy, 1999; Teo *et al*., 2003a). However, the results have not consis-

tently established how learning affects assimilation. For example, the level of a Chief Information Officer's (CIO) IT and business knowledge was found to be effective in influencing IT use (Boynton *et al*., 1994), but senior business executives' 'system of knowing' did not have a significant influence on IT assimilation (Armstrong & Sambamurthy, 1999). Here, 'system of knowing' was operationalised in terms of the interactions between the CIO and members of the top management team, and the construct has some resemblance to the exploitation dimension of ACAP. In the ERP implementation context, ACAP was found to strongly influence knowledge exchange between clients and consultants (Ko *et al*., 2005), but the study did not examine assimilation as a dependent variable.

The above findings highlight the opportunity to explore the impact of ACAP by applying its two-dimensional conceptualisation (Zahra & George, 2002) consisting of PACAP and RACAP. First, *potential absorptive capacity* of an organisation refers to its receptiveness towards acquiring and assimilating external knowledge. In the context of an ERP system, we refer to PACAP as the extent to which a focal organisation has access to external knowledge specific to the ERP system and has acquired and internalized it. This includes knowledge acquired from internal or external sources and pertaining to system-specific features. PACAP also refers to the ERP-related knowledge that is idiosyncratic to the user firm. For example, because an enterprise system such as SAP normally has 25 000 business rules encoded (Lehrer, 2004; Leimbach, 2008), idiosyncratic knowledge could refer to those customisable business rules that are relevant to organisation-specific processes.

An organisation has to make a concerted effort to acquire new knowledge about an ERP system in multiple ways, and PACAP-related routines represent a critical capability for achieving this. For example, these routines facilitate system knowledge acquisition through: learning-by-doing when related expertise developed from past experience is applied (Mustonen-Ollila & Lyytinen, 2003); internal or vendor-provided training sessions (Ko *et al*., 2005); personal relationships with implementation vendors or consulting firms (Hirt & Swanson, 2001); vendor conferences (Hirt & Swanson, 2001); and centralised help desks (Park & Kusiak, 2005). All these are examples of PACAP-related routines (capabilities) that help in the acquisition of ERP-related knowledge. Thus, we propose:

> H1a: A higher level of PACAP will lead to a higher level of ERP assimilation in the post-implementation phase.

While PACAP may enable an organisation to value, acquire and internalize external knowledge, it may not necessarily lead to the exploitation of the knowledge (Zahra & George, 2002). *Realised absorptive capacity* (RACAP) refers to the exploitation capabilities of an organisation (Zahra & George, 2002) and thus complements PACAP because RACAP is internally focused. The distinction was proposed because 'it was observed that some firms possessed strong ingenuity to understand complex technical problems but were not as effective in translating such knowledge into product innovation strategies' (Zahra & George, 2002, p. 191). In our context, the roots of RACAP lie in the ability to exploit the benefits from ERP systems by facilitating greater usage. However, because cross-functionality is a key feature of ERP systems, one of the greatest impediments to ERP usage are the cross-departmental coordi-

nation hurdles (Boudreau & Robey, 2005; Chang, 2006; El Amrani *et al*., 2006; Häkkinen & Hilmola, 2008). Therefore, to facilitate cross-functional communication and collaboration, organisations nurture structural, cognitive and relational ties spanning subunits, which essentially underlie overlapping knowledge structures (Nahapiet & Ghoshal, 1998). These knowledge structures essentially represent the commonality among subunits in terms of their understanding of the ERP system, or readiness towards exploiting the system. An example of a knowledge structure that helps users develop a holistic mental model of their business processes (Baskerville *et al*., 2000) is the shared goal of the ERP system communicated by the top management. A shared goal facilitates users' comprehension of cross-unit interdependencies so that all departments have a common understanding of the broader objectives and implications of the system (Baskerville *et al*., 2000). Thus, the capabilities represented by RACAP play a critical role in ERP assimilation. Therefore, we expect:

H1b: A higher level of RACAP will lead to a higher level of ERP assimilation in the post-implementation phase.

Moderating effects of absorptive capacity

We propose that much of the IT-related adaptation organisations engage in during assimilation not only is a response to external institutional pressures (Liang *et al*., 2007) but also is moderated by the organisation's ACAP. In the case of enterprise systems, organisations have reserves of knowledge about the innovation by virtue of training and the educational background of the personnel. Organisations also develop salient intra-organisational linkages to promote discourse about usage of enterprise systems (Hirt & Swanson, 2001). Thus, the extent to which they can imitate their successful competitors' ERP practices or adopt the best ERP practices of their industry is a function of their knowledge stock and their capability to cultivate an internal discourse aimed at assimilating the innovation. Therefore, it is necessary to hypothesise the role of ACAP in terms of how it moderates the impacts of external institutional pressures.

Although the extant literature and this study conceptualise three types of institutional forces – mimetic, normative and coercive (DiMaggio & Powell, 1983; Teo *et al*., 2003b; Liang *et al*., 2007), we focus on only the former two when developing our *moderating hypotheses*, and for a theoretical reason, exclude the coercive forces. The reason is that it is at the discretion of organisations whether to imitate their competitors or follow the norms formed by external sources in the assimilation phase. ACAP may have a role to play here because its underlying routines are eventually enacted subtly at the individual level, and through the same channels that the mimetic and normative influences largely operate. In contrast, coercive forces are typically more explicit because they tend to be conveyed by regulatory bodies, industry associations and the like. In many contexts, coercive forces are also akin to survival necessities and thus taken for granted, such that the role of ACAP in influencing the transmission of coercive forces is marginalised. Thus, in the remainder of this section, we develop our hypotheses related to how ACAP moderates the effect of two of the three external institutional pressures – mimetic and normative pressures – on ERP assimilation in organisations.

The mimetic mechanism operates when, under conditions of outcome uncertainty, organisations model themselves after those other organisations in their field which are perceived to be more successful or legitimate (Galaskiewicz & Wasserman, 1989). In addition to conferring legitimacy, which is a key imperative for organisational actors, mimicry also helps them economise on search costs and reduces the uncertainty related to the outcomes of their decisions. We argue that organisations that have a greater ACAP have richer routines that are activated during assimilation stage, which is a critical juncture in the ERP life cycle because organisations transition from receiving support from consultants and vendors to self-support and self-service (Attewell, 1992; Hirt & Swanson, 2001; Ko *et al*., 2005). Thus, while users are forced to exploit an ERP system by engaging in *learning-by-using* and *learning-by-doing*, the organisation becomes exposed to cues from successful competitors, which are captured by ACAP-related routines. The high degree of uncertainty in the post-implementation stage should result in ACAP-related routines not only capturing and exploiting ERP-knowledge but simultaneously absorbing institutional cues about successful competitors and industry norms.

Therefore, while we propose that PACAP and RACAP expose the organisation more to institutional influences, we also suggest that they do so differently because of the knowledge routines distinctive to each of these two dimensions of ACAP. For example, acquisition of knowledge imparted to employees during training sessions from ERP vendors/consultants comes bundled with cues about how successful competitors are operationally and strategically using certain ERP features or process customisations. Thus, while higher levels of PACAP is associated with acquisition and absorption of new system-related knowledge, a non-purposive or an unintended consequence is that PACAP-related routines expose firms more keenly to mimetic influences. Thus, we propose:

> H2a: PACAP positively moderates the effect of mimetic forces on the degree of ERP assimilation in post-implementation phases.

Similarly, we propose that RACAP, which represents knowledge capabilities that facilitate ERP systems exploitation, also renders organisations more porous towards mimetic influences. Exploitation of acquired knowledge is an entrepreneurial activity because employees devise newer ways to either alter current business processes or to adapt the ERP system features to their task needs, some efforts often being led by the users themselves with the IT staff playing a more limited role (Hirt & Swanson, 2001). RACAP also represents greater willingness of entrepreneurial actors to access diverse sources of knowledge in order to adapt the ERP system. As users begin to grasp the inter-unit interdependencies partly through socialisation (Baskerville *et al*., 2000) with other electronically linked departments, they expose themselves more to mimetic influences affecting even the linked subunits. Thus, socialisation increases the reach of users' social networks beyond other subunits to the external entities linked to those subunits (Van den Bulte & Moenart, 1998). Therefore, despite the significant tacitness underlying the RCACP routines, they expose organisations to mimetic influences by expanding the reach of their information channels. Therefore, we expect:

H2b: RACAP positively moderates the effect of mimetic forces on the degree of ERP assimilation in post-implementation phases.

Normative influences arise from the professionalisation of organisational actors in the extended network within the organisational field. As DiMaggio & Powell (1983) write: '. . . . we interpret professionalization as the collective struggle of members of an occupation to define the conditions and methods of their work, to control "the production of producers", and to establish a cognitive base and legitimation for their occupational autonomy' (p. 152). Normative influences result from *agreement* among the members of the organisational field and are distinct from mimetic influences.

A consequence of the uncertainty regarding the degree of adaptation during ERP assimilation is that users tend to rely more on the professional norms that propagate throughout the community network of suppliers, vendors and customers (Swanson, 1994; Swanson & Ramiller, 1997). These are external entities in the highest proximity to the users in the post-implementation stage. In this type of environment, the 'organizing vision' (Swanson & Ramiller, 1997) becomes a significant force that shapes individual beliefs, attitudes and ultimately behaviour. We argue that norms accepted in the subset of external entities – suppliers, vendors and customers – have a significant influence on the assimilation of the ERP system within the organisation. These norms guide the users about the extent to which they should adapt their work routines to the ERP system and conversely what features of the ERP system can be modified to suit their needs.

As the business activities of suppliers, customers and other partners become interdependent (Swanson & Ramiller, 1997), norms regarding ERP usage become important because they guide users and managers in the face of uncertainty. We argue that in the case of complex innovations, the PACAP of an organisation helps it to sift, filter and absorb the extensive amount of information about using ERP systems that is acquired from the organisational field. The routines of knowledge acquisition and absorption that underlie PACAP become instruments, which capture the ERP assimilation norms. Thus, we expect:

H3a: PACAP positively moderates the effect of normative forces on the degree of ERP assimilation in post-implementation phases.

Because the routines of RACAP are instantiated through the development of common language and shared goals, they are a fertile channel for diffusing external institutional norms within an organisation. Users of ERP systems attempt to cope with, and adapt to, the new system features by a process of discovery, by transforming the (external) absorbed knowledge about the new system to generate new opportunities (Lengnick-Hall *et al*., 2004). For example, RACAP can help an employee to recognise that certain data that are now integrated by virtue of the new ERP system could be fed into an add-on module to generate novel insights for another functional user. The greater the extent of adoption of the ERP system within the institutional field of an organisation, the more prevalent are the norms that emerge around the usage of the ERP system. RACAP-related routines facilitate the transmission of such norms within the organisation to the points of use of the ERP system. Therefore, we expect:

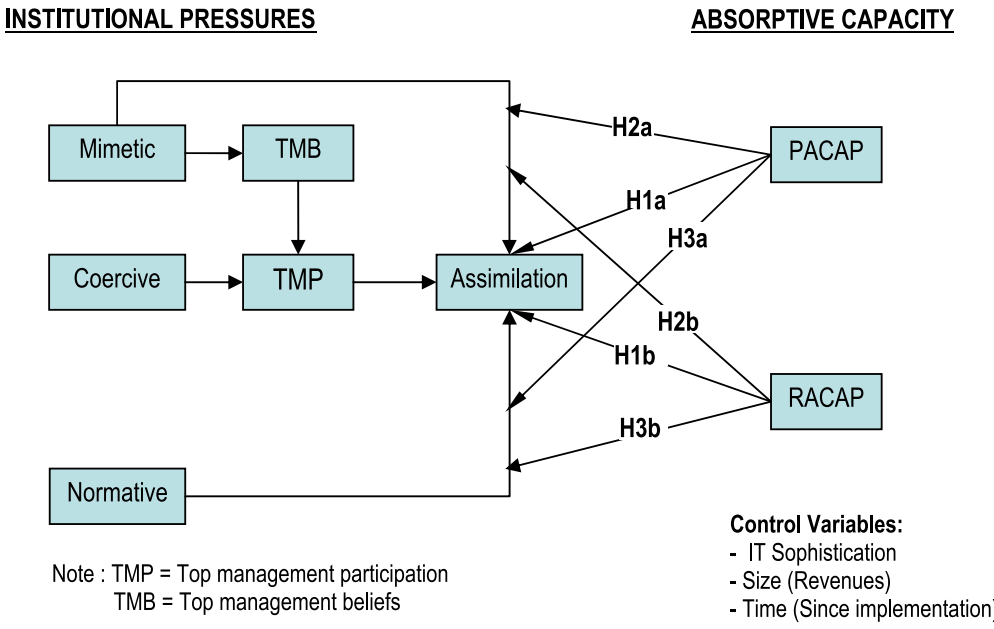

Figure 1. Research model.

H3b: RACAP positively moderates the effect of normative forces on the degree of ERP assimilation in post-implementation phases.

Because this study is based on the ERP assimilation model of Liang *et al*. (2007), to maintain the theoretical integrity across the two studies, the above research model (Figure 1) also includes all of the constructs and relationships in the assimilation model developed in Liang *et al*. (2007). However, the focus of this study is on testing the direct and moderating impacts of absorptive capacity.

RESEARCH METHOD AND DATA

Instrument development

The survey instrument was the same as the one described in Liang *et al*. (2007). Due to space limitation, readers are referred to that publication for a detailed description. The measurement items are summarised in the Appendix for convenience. In the following section, we provide a detailed description of the operationalisation of key constructs used in our model and hypotheses.

Assimilation, mimetic and normative pressures

We refer the reader to Liang *et al*. (2007) for a detailed explanation of these constructs and the Appendix for literature bases underlying these constructs. The scale for Assimilation was

based primarily on Massetti & Zmud (1996). Following Teo *et al*. (2003b), mimetic pressures were measured in terms of the perceived extent to which competitors had benefited by *adopting* ERP; normative pressures were measured in terms of the perceived extent to which members of an organisational field have adopted ERP and the extent to which the government and industry agencies promote the use of IT and especially the ERP systems as best practices.

Absorptive capacity

It is well recognised that scales for knowledge-related constructs need to be devised specific to the context. Though we found no scales to measure PACAP or RACAP in our context, existing literature provided a rich basis on which we created the scales anew for both PACAP and RACAP (see Table A1 in the Appendix). In the post-implementation stages of ERP systems, most of the know-how of the new system has been transferred from the vendors and consultants to the users who are now expected to be in the self-service mode (Attewell, 1992; Hirt & Swanson, 2001). Therefore, it is essential to capture the extent of ERP-related knowledge transferred from the consultants and vendors to the organisational users and absorbed by the latter. We measured PACAP using a five-item reflective scale, which refers to the ERP-related training, the general level of technical support that the organisation can provide and the degree of knowledge acquired from the ERP vendor. The choice of these items is consistent with the knowledge-as-stock notion and captures the knowledge stock about the new ERP system acquired by the firm. All of the items were based on the conceptual discussion in the literature (Zahra & George, 2002) and designed to match the context of post-implementation ERP usage. Thus, while recent studies in other contexts, such as financial services innovation (Jansen *et al*., 2005) or industrial products (Lichtenthaler, 2009), developed their own scales for PACAP and RACAP, these scales are different from ours for the above reasons.

We relied on the results of exploratory factor analysis to split the five items for PACAP into two sets to represent two sub-dimensions. Because the majority of problems related to ERP use stem from its cross-functionality (Baskerville *et al*., 2000; Hirt & Swanson, 2001; Robey *et al*., 2002), three items captured the extent to which an organisation had cognitive and relational structures in place that led to easier *exploitation* of the ERP system.

Control variables

We included three control variables – size, time since implementation and IT sophistication. IT sophistication was measured as a reflective scale (Cohen & Levinthal, 1990; Bharadwaj, 2000) (see Table A2, Appendix). Size is measured by the log of revenue as a proxy for organisational slack (Lee & Kim, 1998; Ravichandran, 2005). Time since implementation (in months) was included to account for the temporal nature of innovation assimilation (Argote *et al*., 1990).

Data collection

We used a field survey method to tap responses from managers of Chinese companies that had implemented ERP systems. A sample was drawn from the clients of UFIDA, a leading ERP

vendor in the Chinese ERP market. We requested a senior marketing manager at UFIDA to randomly distribute 100 questionnaires to the directors of UFIDA's 14 subsidiaries and 15 offices. With the help from UFIDA, we were able to access the key person in each company of interest. These respondents not only were involved during ERP vendor selection but also supervised its implementation and oversaw the subsequent use and frequently interacted with other members of the top management team at the client organisation. In order to preserve the relative objectivity of ERP assimilation measures, the key informants were requested to provide answers based on factual objects such as minutes of meetings or company documentations as much as possible. Further, UFIDA's sales representatives had continuous interactions with their clients even after implementations were completed and they intentionally monitored their ERP usage for the purpose of acquiring additional sales and maintenance contracts. This partly mitigates the concern that the survey responses would suffer from inaccurate recall.

Of the 100 questionnaires distributed, 80 questionnaires were returned and 77 questionnaires were completed and usable for data analysis, showing an effective response rate of 77.0%. Among the responding companies, most of them were in manufacturing (67.5%) and service (27.3%) industries, and about half (45.5%) were privately owned and about one quarter (26%) were publicly traded companies. The size of the companies varied significantly, with a mean of 880 employees and $48 million in revenue based on the exchange rate at the time of data collection in February–May 2004. On average these companies had been using ERP systems for 22 months, with a standard deviation of 15.5 months. IT directors and finance executives accounted for over two thirds of the respondents (see Liang *et al*., 2007 for details of the respondent profile information).

RESULTS AND ANALYSES

Because our research model contains both reflective and formative constructs, Partial Least Square (PLS) was chosen for data analysis. Unlike covariance-based structural equation modelling techniques, PLS employs a component-based approach for estimation purposes (Lohmoller, 1989) and can handle reflective as well as formative factors (Chin & Marcoulides, 1998). PLS also places minimal restrictions on sample size and residual distributions (Chin *et al*., 1999). In general, PLS is better suited for explaining complex relationships as it avoids two serious problems of covariance-based SEM methods – inadmissible solutions and factor indeterminacy (Fornell & Bookstein, 1982), and it has been widely used in IS research.

Measurement evaluation

Table 1 exhibits the composite reliability and average variance extracted (AVE) of the reflective constructs of PACAP, RACAP and the IT sophistication constructs (the expanded list is in Table A3 in the Appendix). All the reliability coefficients are above 0.70 and each AVE is above 0.50, indicating that the measurements are reliable and the latent construct can account for at

Table 1. Loadings of key indicator variables

Construct		Indicator	Mean	SD	Loading	*t*-value
PACAP	PACAP1	1	3.75	0.84	0.856	23.165
		2	3.45	0.90	0.845	25.295
		3	3.44	0.88	0.680	5.464
	PACAP2	1	3.10	0.89	0.902	47.542
		2	3.35	0.82	0.892	31.429
RACAP		1	2.88	0.88	0.727	5.915
		2	3.32	0.99	0.913	19.678
		3	3.58	0.87	0.890	12.786
IT sophistication		1	46%	28%	0.754	2.423
		2	68%	31%	0.753	3.197
		3	13%	16%	0.819	3.069
		4	8%	15%	0.705	3.202
ERP assimilation		Volume	54%	21%	n/a	9.866
		Diversity	2.92	1.68	n/a	12.780
		Depth	2.60	0.63	n/a	3.086

PACAP, potential absorptive capacity; RACAP, realised absorptive capacity; IT, information technology; ERP, Enterprise Resource Planning; SD, standard deviation.

least 50% of the variance in the items. The factor loadings are in an acceptable range and the *t*-values indicate that they are significant at the 0.01 level. To further ascertain discriminant validity, it was also confirmed that the square root of the AVE of each construct is greater than all of its correlations with other constructs, supporting discriminant validity (Chin & Marcoulides, 1998) as shown in Table 2.

Common method bias

The data of each company were collected from a single key informant. As with all self-reported data, there is potential for common method bias resulting from multiple sources such as consistency, motif and social desirability (Podsakoff & Organ, 1986). Therefore, the questionnaire asked the respondent not to estimate ERP assimilation outcome measures according to personal experience but to get this information from minutes of company meetings or documentation. We also conducted a Harmon one-factor test (Podsakoff *et al*., 2003; Malhotra *et al*., 2006) on the 10 conceptually crucial variables in our theoretical model. Results from this test showed that 10 factors are present, and the covariance explained range from 7.07% to 13.29%, indicating that common method biases are not a likely contaminant of the results observed in this study.

Hypotheses testing

PLS is used to conduct the structural path analysis. As shown in Figure 2, the path between PACAP and assimilation is significant at the 0.01 level, supporting H1a. RACAP's direct effect on assimilation (H1b) is weakly supported (0.1 level). Table 3 presents a summary.

Table 2. Inter-construct correlations and AVEs

	Construct	CR	AVE	1	2	3	4	5	6	7	8	9	10
1	TMB	0.789	0.577	**0.760**									
2	TMP	0.839	0.637	0.387	**0.798**								
3	MIME	0.852	0.658	0.209	0.135	**0.811**							
4	COER	0.902	0.796	0.154	0.454	0.077	**0.892**						
5	NORM	0.906	0.763	0.042	–0.034	–0.099	0.144	**0.873**					
6	PACAP1	0.839	0.636	0.183	0.163	0.132	0.075	0.167	**0.797**				
7	PACAP2	0.892	0.804	0.312	0.372	0.352	0.023	0.239	0.435	**0.897**			
8	RACAP	0.884	0.719	0.104	0.307	0.359	0.100	0.300	0.558	0.465	**0.848**		
9	IT sophist.	0.844	0.576	0.248	–0.133	0.090	0.127	0.149	0.462	0.235	0.342	**0.760**	
10	Assimilation	n/a	n/a	0.396	0.522	0.390	0.144	0.333	0.412	0.464	0.348	0.286	n/a

AVE square roots are shown as bolded in diagonal cells.

CR, composite reliability; AVE, average variance extracted; TMB, top management belief; TMP, top management participation; MIME, mimetic pressure; COER, coercive pressure; NORM, normative pressure; PACAP, potential absorptive capacity; RACAP, realised absorptive capacity; IT, information technology.

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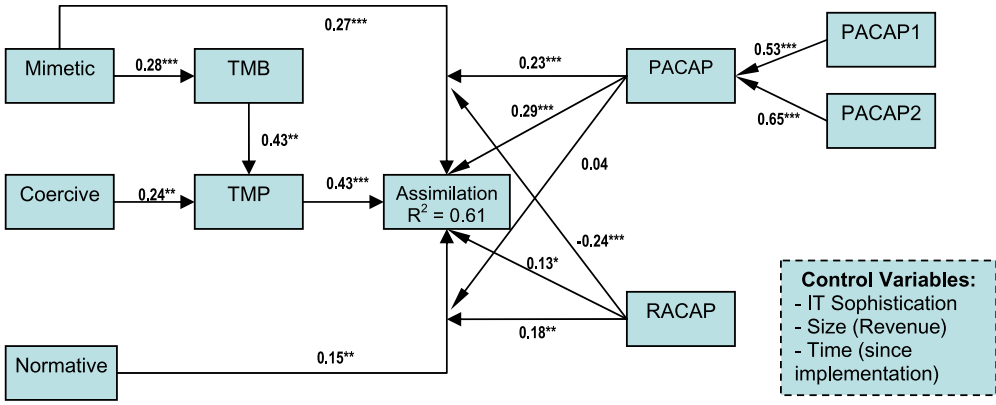

Figure 2. PLS test results.

Table 3. Hypothesis testing

Hypothesis	Findings
H1a: A higher level of potential absorptive capacity will lead to a higher level of ERP assimilation.	Supported ($p < 0.01$)
H1b: A higher level of realised absorptive capacity will lead to a higher level of ERP assimilation.	Supported ($p < 0.1$)
H2a: PACAP positively moderates the effect of mimetic forces on the degree of ERP assimilation.	Supported ($p < 0.01$)
H2b: RACAP positively moderates the effect of mimetic forces on the degree of ERP assimilation.	Not supported *Surprising negative effect (p < 0.01)*
H3a: PACAP positively moderates the effect of normative forces on the degree of ERP assimilation.	Not supported
H3b: RACAP positively moderates the effect of normative forces on the degree of ERP assimilation.	Supported ($p < 0.05$)

PACAP, potential absorptive capacity; RACAP, realised absorptive capacity; ERP, Enterprise Resource Planning.

Following Chin *et al*. (2003), we tested the four hypothesised moderating effects out of which we found support for two (H2a and H3b). We found that PACAP indeed strengthens the effect of mimetic pressures on the degree of ERP assimilation (b = 0.23, $p < 0.01$). Similarly, RACAP strengthens the effect of normative pressures (b = 0.18, $p < 0.05$). However, surprisingly RACAP weakens the effect of mimetic pressures (b = –0.24, $p < 0.01$). Finally, the moderating effect of PACAP on the Normative → Assimilation relationship is not significant.

Additional analyses of effect sizes and simple slopes were conducted to provide further evidence for these moderation effects. As Chin *et al*. (2003) suggested, we calculated Cohen's effect size (f^2) to confirm the overall moderating effects:

$$f^2 = \frac{R^2_{InteractionModel} - R^2_{MainEffectModel}}{1 - R^2_{InteractionModel}}$$

The Cohen's effect size was 0.34, indicating the existence of strong moderating effects. Following Carte & Russell (2003), we tested whether the variance explained by the moderation effects is significant beyond the main effects by calculating the F-statistic from the incremental R-squares of the models with moderating effects. Four models were run including only one of the hypothesised moderating effect in turn and excluding the rest. Then, an F-statistic was computed by comparing the R-squares with a base model that included only the main effects. The F-statistic for the model including only the moderating effect PACAP $\times$ Normative was not significant at the 0.05 level, but the rest of the moderating effects are all significant at the 0.05 level, thus consistent with the significance of the path coefficients above. A fifth model was run by including all moderating effects. The F-statistic for this model is 5.71, significant at the 0.001 level.

In addition, a power analysis was performed to demonstrate that the moderation tests have adequate power. We used Cohen's (1988, p. 420) power table for multiple regression (MR) analysis to calculate power values for our PLS model. This is because PLS is performed by iterative regression analysis (Chin & Marcoulides, 1998). Hence, power analysis on MR should also be applicable for PLS. From the power table (Cohen, 1988), we find that the power value at 0.05 level for detecting the effect size of 0.34 is above 0.90, suggesting that the moderation effects are unlikely to be biased by Type II errors.

Following Cohen *et al*. (2002), we use plots to demonstrate the three significant moderation effects. In each plot, two regression lines are identified at one standard deviation above and below the mean value of the independent variable. These plots are shown in Figure 3. For example, relative to the low PACAP line, the high PACAP line in Figure 3a is steeper, and its slope is larger than the low PACAP line (positive moderation). Thus, as PACAP increases, the impact of mimetic pressures on assimilation strengthens. In contrast, the high RACAP line in Figure 3b is flatter, and its slope is smaller than the low RACAP line (negative moderation), suggesting that the impact of mimetic pressures on assimilation attenuates as RACAP strengthens.

DISCUSSION

The results offer strong support for one of our two main hypothesised effects (PACAP) and weak support for the other one (RACAP). Specifically, the amount of knowledge stock that a company maintains regarding the ERP systems (i.e. PACAP) indeed results in a higher level of assimilation. Interestingly, the exploitation routines constituting RACAP and instantiated as cross-unit knowledge structures are found to be only weakly linked to ERP assimilation. However, RACAP plays a more nuanced role by moderating the effect of both institutional pressures.

Two hypothesised moderating effects are strongly supported and two others are not. These results reveal some interesting insights. First, mimetic forces signal competitors' success with ERP systems and thus are weak, decontextualised signals, introduced by consultants and vendors only as exemplars. Therefore, we argued that PACAP-related routines are oriented to sift through large amounts of external knowledge (e.g. from vendors and user conferences)

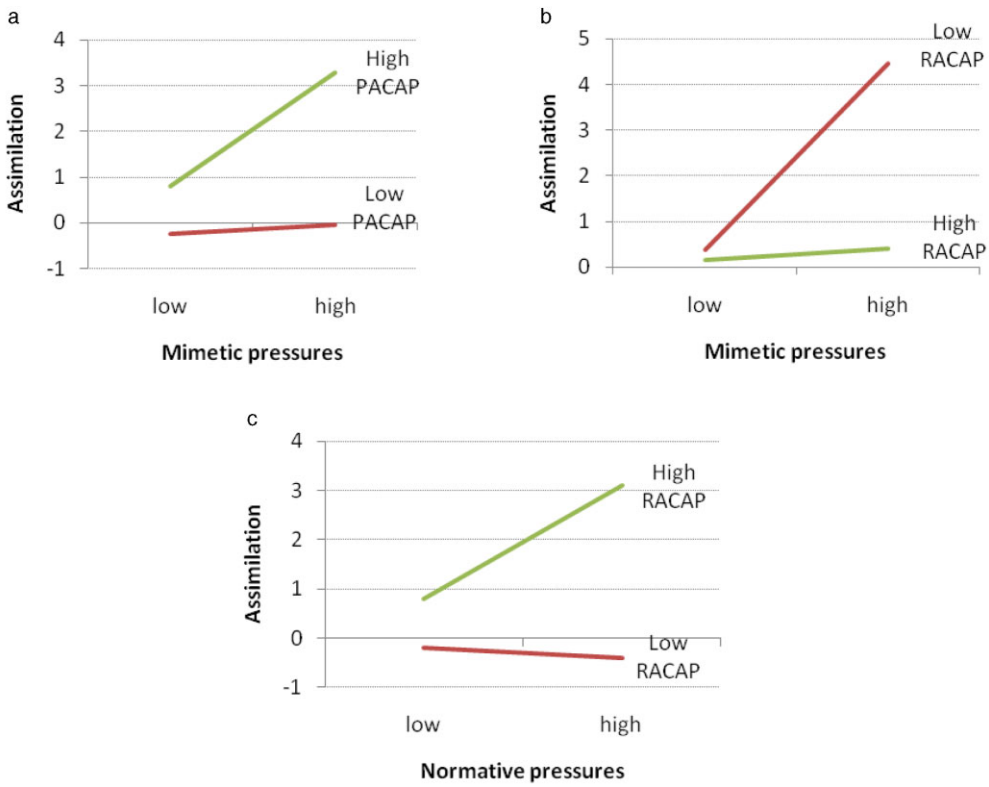

Figure 3. The moderating effects of absorptive capacity.

regarding ERP systems, as evidenced by the significant moderating effect of PACAP on mimetic pressures (H2a). However, the moderating effect of PACAP on normative pressures (H3a) is not significant. In retrospect, this suggests that PACAP may not play a significant role in transmitting and translating industry norms to the user organisation. Second, another insight can be gained by comparing why H2a is significant but H2b is not. This is perhaps because of a nuanced distinction between RACAP and PACAP. RACAP represents an organisation's ability to 'contextualize' industry norms emanating from suppliers, customers and other external entities, while PACAP largely results in accumulation of technical knowledge stock about the ERP system. Mimetic influences are weak, uncontextualised signals introduced by media and consultants as exemplars, which are therefore less augmented by RACAP than by PACAP. Third, the moderating effects of RACAP (H2b) are opposite to those of PACAP (H2a). Exploitation routines underlying RACAP are more compatible with the highly contextualised normative influences from customers, suppliers and professional peers, which emerge from close proximity to employees' work domain. Therefore, in the presence of higher levels of RACAP, normative influences (H3b) are transmitted more readily than are mimetic ones (H2b),

resulting in greater assimilation. Fourth, instead of the hypothesised positive moderating effect of RACAP in H2b, the negative effect is unexpected. We conjecture that highly developed RACAP-related routines make organisations capable of synthesising their own context-specific knowledge regarding the ERP system. Organisations having strong interdepartmental networks avoid relying on mimicry to reduce their search costs for ERP usage (Swanson & Ramiller, 2004) but more on their internal capabilities.

Theoretical implications

The first implication of this study is that it is important to distinguish between different ACAP-related routines in the studies of complex enterprise systems, and the four-dimensional model offered in the literature (Zahra & George, 2002) can serve as a useful framework towards this end. Fleshing out the distinctions between PACAP and RACAP may help to better understand why ERP investments, at times, do not yield the expected level of benefits. For example, RACAP by itself appears to be weakly significant, but both its interaction effects are significant in the assimilation model. Second, the findings imply that routines for ACAP may purposively or inadvertently become moderators that transmit the institutional influences, albeit in distinct ways. The different rationales provided to support our hypotheses show that organisational ACAP does not bring benefits in isolation – it interacts with the institutional field an organisation is embedded in to facilitate or hinder enterprise systems assimilation. Further, ACAP may also serve to insulate an organisation from somewhat unwanted influences as is shown in the surprising negative moderation of RACAP on the effect of mimetic pressures. Thus, the interactions between internal (ACAP) and external (institutional) factors offer a richer and a more nuanced understanding of ERP assimilation beyond prior work. In summary, this contributes to the technology assimilation research by linking two significant bodies of theories – institutional and organisational learning (Boyd & Bresser, 2004; Poole & Van de Ven, 2004; Van de Ven & Hargrave, 2004).

Practical implications

The significant relationship between PACAP and ERP assimilation suggests the importance of training and support during this stage and calls for organisational leaders to build the capability to better acquire and assimilate external knowledge. Specific initiatives such as help desk, mentoring programs and retraining workshops all create a highly accessible source of external knowledge for ERP users. In addition, what is particularly interesting in our construct measures is the importance of providing users with information about not only the ERP modules they are using but also other ERP modules (El Amrani *et al*., 2006).

Weak support is found for the relationship between RACAP and ERP assimilation. Thus, the direct effect of the common business language shared by the various departments on ERP assimilation is weak and so is the effect of a shared goal for an ERP system. Yet this does not mean that RACAP is trivial for managers to pursue. The significant moderating role of RACAP between normative pressures and assimilation illustrates how RACAP contributes towards assimilation. The effect of normative pressures on the degree of ERP usage will be strength-

ened if most functional units in the organisation have achieved a common understanding of the system and are able to effectively coordinate their system usage behaviour. However, inter-departmental knowledge structures that constitute RACAP may not be developed easily in an organisation. This suggests that a concerted effort to enrich users' shared business vocabulary and shared ERP systems should be an important training goal and carefully implemented through internal workshop cohorts consisting of user-trainees from different departments. Our results suggest that being able to develop 'empathy' for users of the same ERP systems located in other 'upstream' or 'downstream' functional areas (Baskerville *et al*., 2000) speeds up ERP assimilation. Without moderation analysis, the important role of these initiatives could have been overlooked. In short, to materialise the promised benefits of ERP systems, organisations have to continue to develop both PACAP and RACAP because these capabilities either directly or indirectly affect the success of ERP initiative.

Limitations

The above findings need to be considered in light of the following limitations. First, the responding firms are the clients of a single ERP vendor. The theoretical explanations developed in this study might not be readily generalised to a broader context. Future research to validate our findings could include client firms implementing a wider variety ERP products, and larger samples. Second, a longitudinal study would add more depth to our insights by understanding the role of organisational ACAP at different stages of IT assimilation and by allowing causal inferences to be made. Third, every complex system has its unique features, which make it distinct from other types of systems. For example, an ERP system is primarily an intra-organisational system whereas a supply chain management (SCM) or a customer relationship management (CRM) system is more inter-organisational, which brings with it a unique set of challenges. A broader understanding of complex systems assimilation can be developed by extending future studies to these domains. Fourth, a key methodological limitation of this study, namely the use of a single respondent in each sample organisation, constrains us from inferring stronger causality. Irrespective of the fact that our statistical tests for common method bias are negative, the greatest assurance of no common method bias is the use of multiple respondents. Fifth, our operationalisation of PACAP and RACAP is narrow and limited to the context of the post-implementation stage of ERP systems. Thus, the measurement scales for these constructs are not necessarily comparable with those developed in the management literature and should be further refined in future studies. Sixth, we did not examine the relationship between RACAP and PACAP in order to minimise theoretical complications in the already complex research model. It is conceivable that the effect of PACAP is mediated by RACAP given the conceptual distinctions of the two constructs. Future research could explore and test this relationship within or outside the context of ERP assimilation. Finally, although the data for this study were collected from China, the proposed theoretical model and the research hypotheses are not specific to the Chinese context or culture. While this may have increased the generalisability of the findings of this study, it may also have limited the richness of the theory and the effectiveness of the prescriptions advanced in this study. Notable scholars of

Chinese management have called for infusing country-specific characteristics into the studies (Martinsons & Westwood, 1997; Tsui, 2006; Davison *et al*., 2008), and many ERP implementation studies have discussed China-specific issues (Liang *et al*., 2004; Xue *et al*., 2005; Avison & Malaurent, 2007). However, to our knowledge there are no country- or culture-specific studies on ERP assimilation, which points to a significant gap in the technology assimilation literature and can be a fruitful area for future research.

CONCLUSION

The study of ERP or other complex systems presents opportunities for developing and testing integrated theories of how influences from the external institutional environment on the assimilation of enterprise systems are moderated by the learning capacity of the organisations (Poole & Van de Ven, 2004). Despite the fact that a large amount of past literature elaborates on the critical success factors and specific theories, we believe that it is time for a comprehensive research model to emerge from such disparate findings. As a modest effort towards this end, we present an understanding of how external institutional pressures interact with an organisation's learning capabilities to affect ERP assimilation. That is, we extended the institutional model of technology assimilation (Liang *et al*., 2007) to include its interaction with an organisation's absorptive capacity. Ours is one of the few empirical studies that attempt to integrate two streams of research on technology assimilation. Our findings suggest that while institutional forces are the key drivers of organisational change resulting from implementation of new IT systems, these forces are nonetheless either enhanced or retarded by the organisations' ability to acquire, assimilate, transform and exploit the new technology.

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REFERENCES

Argote, L., Beckman, S.L. & Epple, D. (1990) The persistence and transfer of learning in industrial settings. *Management Science*, **36**, 140–154.

Armstrong, C. & Sambamurthy, V. (1999) Information technology assimilation in firms: the influence of senior leadership and IT infrastructures. *Information Systems Research*, **10**, 304–327.

Attewell, P. (1992) Technology diffusion and organizational learning: the case of business computing. *Organization Science*, **3**, 1–19.

Avison, D. & Malaurent, J. (2007) Impact of cultural differences: a case study of ERP introduction in China. *International Journal of Information Management*, **27**, 368–374.

Baskerville, R., Pawlowski, S. & McLean, E. (2000) Enterprise resource planning and organizational knowledge: patterns of convergence and divergence. In: *Proceedings of the International Conference on Information Systems*, Ang, S., Krcmar, H.C., Orlikowski, W.J. & Weill, DeGross, J.I. (eds), pp. 396–406. The Association for Information Systems, Brisbane, Australia.

Bharadwaj, A.S. (2000) A resource-based perspective on information technology capability and firm performance: an empirical investigation. *MIS Quarterly*, **24**, 169–193.

Boudreau, M.C. & Robey, D. (2005) Enacting integration information technology: a human agency perspective. *Organization Science*, **16**, 3–18.

Boyd, J.L. & Bresser, R.K.F. (2004) Unfolding competitive patterns: toward an integration of competitive dynamics, organizational learning and institutional perspectives. Presentation at the Academy of Management meeting in New Orleans, LA, USA. Available online at http://www.wiwiss.fu-berlin.de/verwaltung-service/bibliothek/diskussionsbeitraege/diskussionsbeitraege_management/files-diskussionsbeitraege-management/Diskussionspapier_24_04.pdf.

Boynton, A.C., Zmud, R.W. & Jacobs, G.C. (1994) The influence of IT management practice on IT use in large organizations. *MIS Quarterly*, **18**, 299–318.

Carte, T.A. & Russell, C.J. (2003) In pursuit of moderation: nine common errors and their solutions. *MIS Quarterly*, **27**, 479–501.

Chang, H.H. (2006) Technical and management perceptions of enterprise information system importance, implementation, and benefits. *Information Systems Journal*, **16**, 263–292.

Chatterjee, D., Grewal, R. & Sambamurthy, V. (2002) Shaping up for E-commerce: institutional enablers of the organizational assimilation of web technologies. *MIS Quarterly*, **26**, 65–89.

Chin, W.W. & Marcoulides, G.A. (1998) The partial least squares approach to structural equation modeling. In: *Modern Methods for Business Research*, Marcoulides, G.A. (ed.), pp. 295–336. Lawrence Erlbaum Associates, Hillsdale, NJ, USA.

Chin, W.W., Newsted, P. & Hoyle, R.H. (1999) Structural equation modeling analysis with small samples using partial least squares. In: *Statistical Strategies for Small Sample Research*, Hoyle, R.H. (ed.), pp. 307–341. Sage Publications, Thousand Oaks, CA, USA.

Chin, W.W., Marcolin, B.L. & Newsted, P.R. (2003) A partial least squares latent variable modeling approach for measuring interaction effects: results from a Monte Carlo simulation study and an electronic-mail emotion/adoption study. *Information Systems Research*, **14**, 189–217.

Cohen, J. (1988) *Statistical Power Analysis for the Behavioral Sciences*. Lawrence Erlbaum Associates, New York, NY.

Cohen, J., Cohen, P., West, S.G. & Aiken, L. (2002) *Applied Multiple Regression/Correlation Analysis for the Behavioral Sciences*, 3rd edn. Lawrence Erlbaum Associates, Hillsdale, NJ, USA.

Cohen, W.M. & Levinthal, D.A. (1990) Absorptive capacity: a new perspective on learning and innovation. *Administrative Science Quarterly*, **35**, 128–152.

Cooper, R. & Zmud, R. (1990) Information technology implementation research: a technological diffusion approach. *Management Science*, **36**, 123–139.

Davison, R.M., Sia, S.K. & Dong, X.Y. (2008) Introduction to the special issue on information systems in China. *Information Systems Journal*, **18**, 325–330.

DiMaggio, P. & Powell, W.W. (1983) The iron cage revisited: institutional isomorphism and collective rationality in organizational fields. *American Sociological Review*, **48**, 147–160.

El Amrani, R., Rowe, F. & Geffroy-Maronnat, B. (2006) The effects of enterprise resource planning implementation strategy on cross-functionality. *Information Systems Journal*, **16**, 79–104.

Fichman, R.G. (2000) The diffusion and assimilation of information technology innovations. In: *Framing the Domains of IT Research: Glimpsing the Future through the Past*, Zmud, R.W. (ed.), pp. 105–127. Pinnaflex Educational Resources Inc, Cincinnati, OH, USA.

Fichman, R.G. & Kemerer, C.F. (1997) The assimilation of software process innovations: an organizational learning perspective. *Management Science*, **43**, 1345–1363.

Fornell, C. & Bookstein, F.L. (1982) Two structural equation models: LISREL and PLS applied to consumer exit-voice theory. *Journal of Marketing Research*, **19**, 440–452.

Galaskiewicz, J. & Wasserman, S. (1989) Mimetic and normative processes with an interorganizational field. *Administrative Science Quarterly*, **34**, 454–479.

Gattiker, T. & Goodhue, D.L. (2005) What happens after ERP implementation: understanding the impact of interdependence and differentiation on plant-level outcomes. *MIS Quarterly*, **29**, 559–585.

Gosain, S. (2004) Enterprise information systems as objects and carriers of institutional forces: the new iron cage? *Journal of the Association of Information Systems*, **5**, 151–182.

Häkkinen, L. & Hilmola, O.P. (2008) ERP evaluation during the shakedown phase: lessons from an

after-sales division. *Information Systems Journal*, **18**, 73–100.

Hart, P.J. & Saunders, C.S. (1998) Emerging electronic partnerships: antecedents and dimensions of EDI use from the supplier's perspective. *Journal of Management Information Systems*, **14**, 87–111.

Hirt, S.G. & Swanson, B.E. (2001) Emergent maintenance of ERP: new roles and relationships. *Journal of Software Maintenance: Research and Practice*, **13**, 373–387.

Jansen, J.J.P., Van Den Bosch, F.A.J. & Volberda, H.W. (2005) Managing potential and realized absorptive capacity: how do organizational antecedents matter? *Academy of Management Journal*, **48**, 999–1015.

Jones, M.C. & Price, R.L. (2004) Organizational knowledge sharing in ERP implementation: lessons from industry. In: *Advanced Topics in End User Computing*, Vol. 4, Mahmood, M.A. (ed.), pp. 208–231. Idea Group Publishing, Hershey, PA, USA.

Kim, Y., Lee, Z. & Gosain, S. (2005) Impediments to successful ERP implementation process. *Business Process Management Journal*, **11**, 158–170.

Ko, D.K., Kirsch, L. & King, W. (2005) Antecedents of knowledge transfer from consultants to clients in enterprise systems implementations. *MIS Quarterly*, **29**, 59–85.

Lee, G.H. & Kim, Y.G. (1998) Implementing a client/server system in Korean organizations: interrelated IT innovation perspective. *IEEE Transactions on Engineering Management*, **45**, 287–295.

Lehrer, M. (2004) Business software as a general-purpose technology: experience-driven design innovation in ERP systems. In: *Orme Working Paper Series*, William, A. (ed.), University of Rhode Island, Kingston, RI, USA. [WWW document]. URL http://www.cba.uri.edu/research/workingpapers/documents/BusinessSoftwareAsAGeneralPurposeTechnologyExperienceDrivenDesignInnovationInERPSystems.pdf

Leimbach, T. (2008) The SAP story: evolution of SAP within the German software industry. *IEEE Annals of the History of Computing*, **30**, 60–76.

Lengnick-Hall, C.A., Lengnick-Hall, M.L. & Abdinnour-Helm, S. (2004) The role of social and intellectual capital in achieving competitive advantage through enterprise resource planning (ERP) systems. *Journal of Engineering and Technology Management*, **21**, 307–330.

Liang, H.G., Xue, Y.J., Boulton, W.R. & Byrd, T.A. (2004) Why western vendors don't dominate China's ERP market. *Communications of the ACM*, **47**, 69–72.

Liang, H.G., Saraf, N., Hu, Q. & Xue, Y.J. (2007) Assimilation of enterprise systems: the effect of institutional pressures and the mediating role of top management. *MIS Quarterly*, **31**, 59–87.

Lichtenthaler, U. (2009) Absorptive capacity, environmental turbulence, and the complementarity of organizational learning processes. *Academy of Management Journal*, **52**, 822–846.

Lohmoller, J.B. (1989) *Latent Variable Path Modeling with Partial Least Squares*. Physica-Verlag, Heidelberg, Germany.

Malhotra, N.K., Kim, S.S. & Patil, A. (2006) Common method variance in IS research: a comparison of alternative approaches and a reanalysis of past research. *Management Science*, **52**, 1865–1883.

Markus, L.M. & Tanis, C. (2000) The enterprise system experience – from adoption to success. In: *Framing the Domains of IT Research: Glimpsing the Future through the Past*, Zmud, R.W. (ed.), pp. 173–207. Pinnaflex Educational Resources, Inc., Cincinnati, OH, USA.

Martinsons, M.G. & Westwood, R.I. (1997) Management information systems in the Chinese business culture: an explanatory theory. *Information & Management*, **32**, 215–228.

Massetti, B. & Zmud, R.W. (1996) Measuring the extent of EDI usage in complex organizations: strategies and illustrative examples. *MIS Quarterly*, **20**, 331–345.

Massey, A.P., Montoya-Weiss, M.M. & Brown, S.A. (2001) Reaping the benefits of innovative IT: the long and winding road. *IEEE Transactions on Engineering Management*, **48**, 348–357.

Mustonen-Ollila, E. & Lyytinen, K. (2003) Why organizations adopt information system process innovations: a longitudinal study using diffusion of innovation theory. *Information Systems Journal*, **13**, 275–297.

Nahapiet, J. & Ghoshal, S. (1998) Social capital, intellectual capital, and the organizational advantage. *Academy of Management Review*, **23**, 242–266.

Osei-Bryson, K.M., Dong, L. & Ngwenyama, O. (2008) Exploring managerial factors affecting ERP implementation: an investigation of the Klein-Sorra model using regression splines. *Information Systems Journal*, **18**, 499–527.

Park, K. & Kusiak, A. (2005) Enterprise resource planning (ERP) operations support system for maintaining process integration. *International Journal of Production Research*, **43**, 3959–3982.

Podsakoff, P. & Organ, D. (1986) Self-reports in organizational research: problems and prospects. *Journal of Management*, **12**, 531–545.

Podsakoff, P., MacKenzie, S., Lee, J. & Podsakoff, N. (2003) Common method biases in behavioral research:

a critical review of the literature and recommended remedies. *The Journal of Applied Psychology*, **88**, 879–903.

Poole, M.S. & Van de Ven, A.H. (2004) Social, technical, and institutional change: a literature review and synthesis. In: *Handbook of Organizational Change and Innovation*, Poole, M.S. & Van de Ven, A.H. (eds), pp. 374–397. Oxford University Press, New York, NY.

Purvis, R.L., Sambamurthy, V. & Zmud, R.W. (2001) The assimilation of knowledge platforms in organizations: an empirical investigation. *Organization Science*, **12**, 117–135.

Ravichandran, T. (2005) Organizational assimilation of complex technologies: an empirical study of component-based software development. *IEEE Transactions on Engineering Management*, **52**, 249–268.

Robey, D., Ross, J.W. & Boudreau, M.C. (2002) Learning to implement enterprise systems: an exploratory study of the dialectics of change. *Journal of Management Information Systems*, **19**, 17–46.

Swanson, B.E. (1994) Information systems innovation among organizations. *Management Science*, **40**, 1069–1092.

Swanson, B.E. & Ramiller, N.C. (1997) The organizing vision in information systems innovation. *Organization Science*, **8**, 458–474.

Swanson, B.E. & Ramiller, N.C. (2004) Innovating mindfully with information technology. *MIS Quarterly*, **28**, 553–583.

Szulanski, G. (1996) Exploring internal stickiness: impediments to the transfer of best practice within the firm. *Strategic Management Journal*, **17**, 27–43.

Teo, H.H., Wan, W., Wang, X. & Wei, K.K. (2003a) Effects of absorptive capacity on organization predisposition towards information systems. In: *Proceedings of the Twenty-Fourth International Conference on Information Systems*, pp. 121–133. The Association for Information Systems, Seattle, WA.

Teo, H.H., Wei, K.K. & Benbasat, I. (2003b) Predicting intention to adopt interorganizational linkages: an institutional perspective. *MIS Quarterly*, **27**, 19–49.

Todorova, G. & Durisin, B. (2007) Absorptive capacity: valuing a reconceptualization. *Academy of Management Review*, **32**, 774–786.

Tsui, A.S. (2006) Editorial: contextualization in Chinese Management Research. *Management and Organization Review*, **2**, 1–13.

Vachani, S. (2005) Problems of foreign subsidiaries of SMEs compared with large companies. *International Business Review*, **14**, 415–439.

Van den Bulte, C. & Moenart, R.K. (1998) The effects of R&D team co-location on communication patterns among R&D, marketing and manufacturing. *Management Science*, **44**, 681–698.

Van de Ven, A.H. & Hargrave, T. (2004) Social, technical, and institutional change: a literature review and synthesis. In: *Handbook of Organizational Change and Innovation*, Poole, M.S. & Van de Ven, A.H. (eds), pp. 259–303. Oxford University Press, New York, NY.

Xue, Y.J., Liang, H.G., Boulton, W.R. & Snyder, C.A. (2005) ERP implementation failures in China: case studies with implications for ERP vendors. *International Journal of Production Economics*, **97**, 279–295.

Zahra, S.A. & George, G. (2002) Absorptive capacity: a review, reconceptualization and extension. *Academy of Management Review*, **27**, 185–203.

APPENDIX

Table A1. Absorptive capacity sub-constructs

Potential Absorptive Capacity (Zahra & George, 2002)
PACAP1
1. It is well known who can help solve problems associated with the ERP package.
2. Our company can provide adequate technical support for using ERP
3. Our company obtained enough knowledge about using ERP from the ERP vendor.
PACAP2
4. Our company provided ERP training opportunities to employees on a regular basis.
5. The IT department provided specific information for using different ERP modules.
Realized Absorptive Capacity Szulanski (1996)
1. All departments in our company were able to use a common language to talk about ERP usage.
2. All departments in our company had a clear understanding about the goal of using the ERP system.
3. Our company had the ability to manage interdepartmental issues relating to ERP usage.

Table A2. Survey items and literature sources

Construct & References	Scales
ERP assimilation ***Volume***: The average extent to which each business process was conducted using ERP (%). ***Diversity***: The number of functional areas automated by the ERP. ***Depth***: The nature of usage varying from simply planning to more sophisticated usage such as decision making, planning and operation. Hart & Saunders (1998), Massetti & Zmud (1996).	1. Volume: Percentage of the firm's business processes that are using the ERP system (%) 2. Diversity: Number of functional areas that are using the ERP system 3. Depth: Considering all functional areas identified above, identify the overall level in your business at which the ERP system is used: a. Operational level b. Managerial level c. Executive level (decision making)
Top management belief: The extent to which the senior management believed in the potential of ERP to realize operational and strategic benefits. Chatterjee *et al*. (2002)	The senior management of our firm believes that: (1). ERP has the potential to provide significant business benefits to the firm (2). ERP will create a significant competitive arena for firms (3). it is NOT necessary to use ERP to conduct business activities. (1 = strongly disagree; 5 = strongly agree)
Top management participation: The extent to which senior management actively managed the ERP assimilation process. Chatterjee *et al*. (2002)	The senior management of our firm actively: (1). articulates a vision for the organizational use of ERP (2). formulated a strategy for the organizational use of ERP (3). established goals and standards to monitor the ERP project. (1 = strongly disagree; 5 = strongly agree)
Mimetic pressures: Perceived success enjoyed by their competitors who adopted ERP. Teo *et al*. (2003b).	Our main competitors who have adopted ERP: (1). have greatly benefited (2). are favorably perceived by others in the same industry (3). are favorably perceived by their suppliers and customers. (1 = strongly disagree; 5 = strongly agree)
Coercive pressures: Perceived dominating influences from external entities and competitive necessities. Teo *et al*. (2003b), Vachani (2005), DiMaggio & Powell (1983).	(1). The local government requires our firm to use ERP (2).The industry association requires our firm to use ERP (3). The competitive conditions require our firm to use ERP. (1 = strongly disagree; 5 = strongly agree)
Normative pressures: Perceived influences from professional networks, industry associations, and common educational background. Teo *et al*. (2003b).	Please indicate: (1 = very low; 5 = very high) (1). The extent of ERP adoption by your firm's suppliers (2). The extent of ERP adoption by your firm's customers (3).The extent to which the Government's promotion of Information Technology influences your firm to use ERP.
IT Sophistication	Please indicate in percentage terms: (1). The extent of organizational data saved in databases (2). The number of networked computers in percentage terms. (3). The number of digitized documents in percentage terms. (4). Business transactions via EDI in percentage terms.

Table A3. Loadings of the indicator variables on constructs

Construct		Indicator	Mean	SD	Loading	*t*-value
Top management belief		TMB1	3.77	0.65	0.706	4.226
		TMB2	4.10	0.50	0.893	12.137
		TMB3	3.88	0.49	0.783	7.626
Top management participation		TMP1	3.78	0.74	0.829	16.509
		TMP2	3.82	0.66	0.866	24.730
		TMP3	3.87	0.73	0.716	4.515
Mimetic pressure (MIME)		MP1	3.34	0.72	0.728	6.779
		MP2	3.61	0.63	0.856	18.513
		MP3	3.35	0.60	0.844	16.492
Coercive pressure (COER)		CP1	3.23	0.76	0.902	5.590
		CP2	2.82	0.70	0.911	5.332
Normative pressure (NORM)		NP1	2.43	0.83	0.874	17.704
		NP2	2.77	0.84	0.922	35.208
		NP3	3.65	0.84	0.821	9.457
PACAP	PACAP1	1	3.75	0.84	0.856	23.165
		2	3.45	0.90	0.845	25.295
		3	3.44	0.88	0.680	5.464
	PACAP2	1	3.10	0.89	0.902	47.542
		2	3.35	0.82	0.892	31.429
RACAP		1	2.88	0.88	0.727	5.915
		2	3.32	0.99	0.913	19.678
		3	3.58	0.87	0.890	12.786
ERP assimilation		Volume	54%	21%	n/a	9.866
		Diversity	2.92	1.68	n/a	12.780
		Depth	2.60	0.63	n/a	3.086
IT sophistication		1	46%	28%	0.754	2.423
		2	68%	31%	0.753	3.197
		3	13%	16%	0.819	3.069
		4	8%	15%	0.705	3.202