IMPACT OF KNOWLEDGE ACQUISITION ON TECHNOLOGY ASSIMILATION

PRATYUSH BHARATI
University of Massachusetts
Boston, MA 02125

ABHIJIT CHAUDHURY
Bryant University
Smithfield, RI 02917

ABSTRACT

The knowledge-based view of the firm has motivated a rich stream of research on how social factors impact knowledge acquisition by firms. More recently, information systems research has seen an increasing interest in the effect of social influences on software assimilation. This paper combines these two streams to examine the impact of social influences on software assimilation within the firm, using knowledge acquisition as a mediating variable. A structural equation model using formative constructs is developed. In this study of small and medium firms, we investigate the assimilation of three different software systems that support manufacturing. The study finds that the research model is statistically significant and provides evidence that social influences from a firm's peers, vendors, and suppliers promote knowledge acquisition and software assimilation. The study recommends a proactive role on the part of technology and enterprise intermediaries to design SME-appropriate solutions to promote software assimilation.

Keywords: Social influence, knowledge acquisition, technology assimilation, formative constructs

INTRODUCTION

Small and medium-sized enterprises (SMEs) play a very important role in the US economy. SMEs employ half of all private-sector employees, pay more than 45% of the total US private payroll, and have generated 60-80% of net new jobs annually over the last decade. SMEs also employ 40% of high-technology workers such as scientists, engineers, and computer workers. SMEs produce 13 to 14 times more patents per employee than large patenting firms, and these patents are twice as likely as large firms' patents to be among the 1% most cited[85].

SMEs should be an important subject of study for IS academic researchers for several reasons. First, the employment scope of SMEs is significant in the US and EU countries [13,46]; second, the innovation potential of SMEs in many high-tech areas is the primary growth driver of the industry; and finally, this sector drives the renewal process of the economy through birth, death, and restructuring. It is well known that SMEs are different from large firms where information systems are concerned, and organizational theories applicable to large firms may not be applicable to them [8,10,22,70]. However, few IS researchers in the US focus on the SME sector.

This paper focuses on the question, "Do social influences from vendors, consultants, government support agencies, and suppliers affect assimilation of operations control software in the case of small and medium-sized enterprises (SMEs), and is this mediated by knowledge acquisition by the firm?" It investigates SMEs in the high-technology manufacturing cluster based in Greater Boston and studies the influences of cluster members such as competitors, vendors, and others on the direction and pace of innovation. Three software systems are under study: production planning software, material management software, and supplier management software. The paper draws on social capital theory to build a model of software assimilation over the whole technology life cycle. The major contribution of this paper to software assimilation research is that it seeks to fill the void in research on the determinants of technology adoption and assimilation across the full assimilation life cycle using social capital theory.

The impact of social interaction on knowledge and skill acquisition at the firm level has been extensively studied in the organizational and strategy literature (link H1 in Figure 1). Powell and Smith-Doer [65], Podolny and Page [64], and Adler and Kwon [1] have observed the impact of social interactions in helping firms acquire new skills and technologies. Fichman [31, 32] studied the relationship between knowledge acquired by a firm as measured in terms of specialization and related knowledge and how that impacted assimilation of advanced software technologies (link H2 in Figure 1). Liang et al. [54] related absorptive capacity, again measured in terms of knowledge acquired by the firm, to technology adoption in the field of enterprise resource planning systems.

Attewell [4] described how vendors, suppliers, and consultants reduced learning barriers and helped their clients adopt new information technology solutions. Burt [14, 15] and Coleman et al. [20] have related organizational innovation to social ties. One of the benefits of social capital arising out of interaction is social influence [1]. In the field of information systems literature, at the level of users in the organizational context, Hsu and Lin [41], Tong et al. [77], and Kulviwat et al. [51] have related social influence from the environment to technology usage, innovation, and adoption (link H3 in Figure 1).

This research model brings together the two research streams: one from organizational and strategy literature that observes the relationship between social capital and its outcome, social influence, on knowledge and competency acquisition by firms, and the other from information technology literature that relates social influence and knowledge acquisition to technology adoption. Our model is described in Figure 1.

The contributions of this paper are several. In much of the MIS literature, technology adoption has often been treated as synonymous with user acceptance. For instance, Venkatesh et al. [80] provided eight different approaches and referred

Received: February 1, 2010 Revised: May 6, 2010 Accepted: June 23, 2010

to approximately hundred papers based on models of user acceptance. Unlike in large firms, in SMEs users play a limited role in decision-making; decisions are made by owners or owner-managers. Small firms, due to the vulnerability arising out of their limited asset base, are subject to various pressures and influences emanating from their world of peers, customers, and vendors. It was decided that our study of other institutions' influences on SMEs should be the focus of this paper.

IT research on technology adoption for small and medium firms has been limited to the study of motivators and inhibitors [21], acceptance and impact [42, 43], factors relating to satisfaction and success [25], implementation issues [74, 75], and maturity issues [66]. Thong [76] provided an integrated model of IS adoption in small businesses where factors relevant to the firm, such as CEO characteristics and organizational characteristics, were used but only a single environmental factor of competition was used. This paper extends Thong's [76] model of IT adoption in SMEs by looking into a much wider set of social actors that play a role in the full assimilation life cycle and across multiple technologies. Most of the factors studied by Thong [176] have been used as control variables in our research in order to isolate the effect of social influence on the firm.

Finally, much of the existing SME research has been conducted in Europe, Australia, and Asia. This study addresses the lacuna in SME research, which has focused on implementation of technology rather than assimilation of technology [76]. It also addresses some relevant questions for SMEs: How much are SMEs impacted by the environment? What are the appropriate roles of intermediaries such as government agencies in influencing software assimilation? The findings from this research are grounds for developing a more thorough research agenda for SME software assimilation.

The remainder of the paper is organized as follows: The next section sets out the research model. Then, the methodology data analysis and results are discussed. Managerial implications, possible directions of future research, and conclusions are discussed in the last few sections.

RESEARCH MODEL

This research is based on the resource-based view of the firm [6] and its extension, the knowledge-based view (KBV) [71]. According to the KBV, firms are bundles of knowledge and competencies. In the last two decades, several overlapping social theories have emerged that help to explain, among other organizational features, how firms are able to acquire knowledge from social actors in their environment.

According to institutional theory [34], firms are subject to coercive, normative, and mimetic forces from others in their environment. In social exchange theory, power and trust [9] [30] drive exchanges of informational and other goods among firms. While power in social exchange theory is related to coercive forces in institutional theory, trust in social exchange theory could be said to constitute a basis for normative forces to occur. Relationships among firms arising out of interactions result in social capital, according to social capital theory [62]. Such inter-firm networks are a major source of information and knowledge among firms [83]. Small firms, as they are resource-constrained [58], are particularly dependent on their network of relationships with other firms in the environment to learn and rejuvenate their knowledge stock in order to survive and grow [5]. According to Nahapiet and Ghoshal [62], social capital is said to have three dimensions: relational, which is trust- and obligation-oriented; structural, which consists of network ties and frequency; and cognitive, consisting of shared codes and norms. One of the benefits of social capital is social influence [1]. In the field of information systems literature, at the level of users in the organizational context, Hsu and Lin [41], Tong et al. [77], and Kulviwat et al. [51] have related social influence to technology usage, innovation, and adoption.

Social Influence → Knowledge Acquisition

According to Adler and Kwon [1, page 20], social capital is the "sum of resources accruing to an individual or group by virtue of their location in the network of their more or less durable social relations." There are many benefits that accrue from social capital, and one of them is social influence. A firm that is part of such an influence network has access to inter-firm learning [50]. Social capital has been identified as one of the causal factors in diffusion of innovation among firms [14] [15] [20] [67]. One of the consequences of social capital is that it allows the owner of the capital to exercise influence and power over the network members [1]. Burt [16] focuses on entrepreneurs who use this influence in networks to find business opportunities.

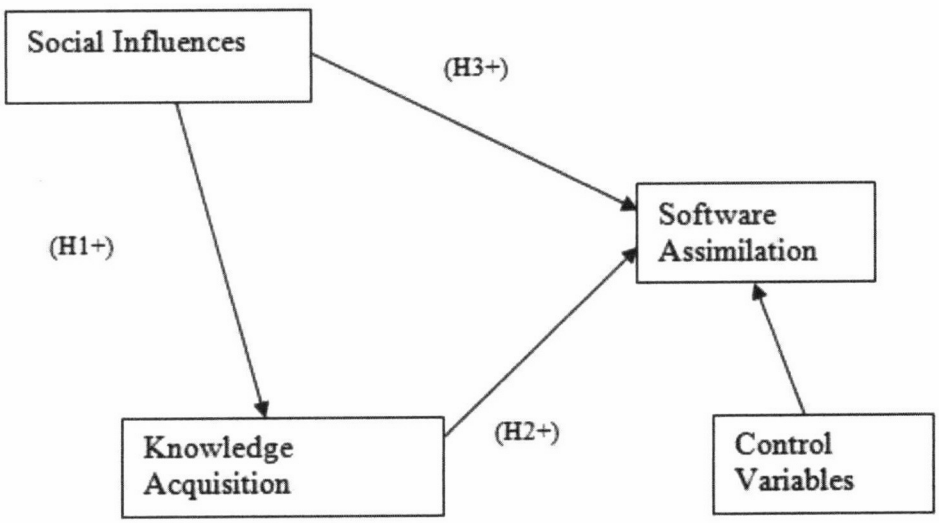

Figure 1: Research Model

There is considerable literature in information systems research that identifies the influence and pressure that customers, vendors, and suppliers exert on the focal firm and result in software assimilation. Knudsen et al. [49] and Webster [81] related the effects on industry of pressure from large customers, such as GM and Ford respectively. Teo et al. [73] researched the role of customers in the adoption of inter-organizational linkages.

Competitive pressures in an industry cause an organization to evolve over time and become similar to other organizations. Haunschild and Miner [40] showed that wide use of an innovation serves as a proxy indicator of its worth and induces other firms to adopt the innovation. Such pressures manifest themselves as practices in the industry and the perceived success of the organizations that have adopted these practices. Copying such practices confers status on the organization [28] and helps minimize experimentation costs in an environment of uncertainty [52]. These influences are akin to forces of contagion in social capital theory. Thong [76] found competition to have a positive effect on IS assimilation in small firms. Haveman [39] and Clemon [19] pointed to an imitation effect in firm behavior in the airline and banking industry. In the context of ERP systems, Liang et al. [54] found that competitors have a role; Son and Benbasat [69] found the same for B2B systems, and Teo et al. [73] for EDI.

According to DiMaggio and Powell [28], pressures are manifested through firm-supplier relationships. Burt [15] and Markus [56] pointed to pressures from a dyadic channel composed of suppliers, vendors, and other intermediaries. Teo et al. [73] found that suppliers affect a firm's intention to adopt inter-organizational systems. Attewell [4] claimed that consultants and vendors provide information and training, thereby reducing knowledge acquisition costs and promoting innovativeness. Thong et al. [105] found that vendors and consultants played an important role in IS implementation, which was extended to the case of small firms by Thong et al. [75].

Organizational decision-makers are affected by norms and standards that are institutionalized in their environments, such as business and professional circles [28]. Such influences by professional networks are related to prominence in social capital theory [29]. King et al. [47] and Teo et al. [73] found evidence that participation in industry and trade associations and with government-sanctioned bodies constitutes pressure on a firm. Rogers [68 p. 408] discussed the positive role of openness (defined as "the degree to which members of a system are linked to other individuals who are external to the system") as it relates to innovativeness. Hence our first hypothesis:

Hypothesis 1: The greater the social influence exerted by competitors, customers, government agencies, professional networks, suppliers, and IT vendors on a firm, the more knowledge the firm acquires about production planning, material management, and supplier management software solutions.

Knowledge Acquisition → Software Assimilation

In the technology adoption literature at the firm level, two sets of antecedent factors are common: firm characteristics and innovation characteristics. Firm characteristics that have been found to result in technology adoption have included the knowledge state of the firm [31] [32][35]. Having a greater variety of specialists gives a firm an enhanced knowledge base, and Fichman [32] found specialization to be an important variable affecting assimilation of object-oriented technologies. The absorptive capacity of a firm has been seen to promote adoption of technologies such as enterprise resource planning by Liang et al. [54]. In their research, absorptive capacity was measured in terms of the prior state of knowledge acquired by the firm that was relevant to the technology being absorbed.

Software assimilation is a kind of organizational innovation [32]. Such innovations have been seen to result from knowledge variety and specialization in the firm. For instance, Kimberely and Evanisko [46] ascribed the innovativeness of organizations to specialization in related activities, and Rogers [68] credited organizational innovativeness to the range of occupational specialties. The existing knowledge state in the firm facilitates the absorption of new but related knowledge. Similarly, a greater variety of specialization provides a broader base of understanding that promotes assimilation of new technologies [46]. We therefore hypothesize the following:

Hypothesis 2: The greater the knowledge acquired about production solutions, the greater the degree of assimilation of production planning, material management, and supplier management software in the firm.

Social Influence → Software Assimilation

The strategy literature is replete with instances of social capital as an antecedent to firm-level innovation. Gabbay and Zuckerman [33] related social capital to innovation in R & D. Hansen [36] observed that network relationships among firms promoted knowledge sharing. Tsai and Ghoshal [78] and Nahapiet and Ghoshal [62] ascribed improved intellectual capital in a firm to the firm's social capital. According to Adler and Kwon [1], social influence is just one of the many consequences of social capital. Fichman [31] identifies firm-level innovation with new software assimilation. There has been a recent spurt of research in the information systems field that relates social influence to new technology adoption at an individual user level. For instance, Hsu and Lin [41] show that acceptance of blogging technology is dependent on social influence and knowledge sharing in the network; Tong et al. [77] relate information systems usage in hospitals to social influences in the social environment of a hospital; and Kulviwat et al. [51] have related social influence to high-tech usage, innovation, and adoption. Hence we hypothesize:

Hypothesis 3: The greater the social influence exerted by competitors, customers, government agencies, professional networks, suppliers, and IT vendors, the greater the degree of assimilation of production planning, material management, and supplier management software in the firm

VARIABLES & MEASURES

In this section, we describe the motivation and sources for our dependent, mediating, and independent variables.

Dependent Variable

This research is focused on the assimilation of three related

Table 1: Guttman Scale for Software Assimilation

Stage	Criteria to enter stage
1) No current activity	No present activity related to the technology
2) Aware	Key decision makers are aware of this technology
3) Interested	Organization is committed to learning more about the technology
4) Evaluated	Organization has acquired technology-related products and has initiated trial
5) Committed	Organization has committed to use the technology in a significant way
6) Limited Installation	Organization has established a program of regular but limited use of technology
7) General Installation	Organization has reached a stage where the technology is used at least for one large and mission-critical system
8) Acquired, Evaluated, and Rejected	Organization had acquired and evaluated the technology and later rejected the technology

types of software systems: production planning software, material management software, and supplier management software. Our interest is in the whole assimilation life cycle, and our measure was developed using suggestions from Rogers [68] and Fichman [39]. The assimilation stage of technology is aggregated over the three software systems. Rogers [68] described the adoption life-cycle process as an innovation-decision process having five steps: knowledge, persuasion, decision, implementation, and confirmation. For IT software systems, Fichman [38] listed six assimilation stages: not aware, aware, interest, evaluation/trial, commitment, limited deployment, and general deployment. After discussion with members of GBMP, a similar scale was adopted for this research, including the following stages: no current activity; aware; interested; evaluated; committed; limited installation; general installation; acquired, evaluated, and rejected; and do not know/other [refer to Table 1]. This technology cluster adoption and assimilation model maps to the theory of Rogers [96]; however, the research model employs a more granular scale by mapping "no current activity" and "aware" to Rogers's knowledge phase, "interest," "evaluation," and "commitment" to the persuasion and decision phase, and "limited deployment" and "general deployment" to the implementation phase.

Independent Variable — Social Influences

The variable of social influence in this paper is a formative construct: that is, it is an aggregation of influences from multiple sources such as customers, suppliers, vendors, and so on. This is in line with guidance provided by Petter et al. [63] that individual formative measures here cause the latent variable — social influence — in the model and are not its reflection. Our latent variable of social influence is similar to variables such as performance, stress, and resources that are composed of aggregated individual constituents [63].

Brass [11] is the basis for our measures that aggregate into the latent variable of social influence. As per Brass, influence is defined as "seem[ing] to have pull, weight or clout." The language "Do customers significantly influence" is in line with Brass [11], and such questions are asked for customers, vendors, suppliers, government agencies, and professional networks.

Mediating Variable — Knowledge Acquisition

The knowledge state of the firm is measured by the mediating variable, knowledge acquisition, which is taken as a formative construct made up of two measures: technology specialization and related knowledge, both based on Fichman [31].

Technology Specialization: According to Kimberley and Evanisko [46], a greater variety of specialization provides a broader knowledge base for the firm. Such knowledge, in turn, leads to increased idea sharing and results in an improved knowledge state of the firm [2].

Related Knowledge: According to Fichman [32], an existing state of related knowledge facilitates absorption of new knowledge. Following Fichman [31], measures were developed to measure the related knowledge of the firm.

Control Variables

To date, there has been considerable research in the information systems field into the antecedents of technology adoption for large firms. There have been a few significant studies of the same issue for small and medium-sized firms. In order to isolate the effects of social influences from the factors that are known to be heavily correlated with technology adoption, two control variables were chosen: firm size and top management attitude.

Firm Size: According to Rogers [67], size is one of the most critical determinants of innovator profile. It has been well established in the innovation diffusion literature that firm size is often a proxy for resource slack and infrastructure, which promote innovativeness [60] [79]. Mytinger [61] provided evidence that firm size is one of the most important variables explaining innovativeness. Mahler and Rogers [55] found that organizational size, revenue, and people employed are positively correlated with telecommunications technology adoption. In the case of small businesses, the role of firm size has been established by Alpar and Reeves [3] and Thong [76].

Top Management Attitude: The IS research literature is replete with evidence that top management's support is crucial for technology adoption. Jarvenpaa and Ives [51] and Chatterjee et al. [17] have established the role of senior management. More specifically, in the case of small businesses, the importance of the role of top management and the CEO has been verified by Yap et al. [82] and Thong [76], in the case of an owner-CEO who is often the top management for a small firm. Thong et al. [75] provided an extensive list of references showing the positive relationship between top management support and IT adoption.

RESEARCH METHOD AND DATA

Constructs were developed after searching literature in the theory domain which generated sample items. A pilot study was conducted with randomly selected SMEs in order to assess the reliability and validity of the constructs. Massachusetts

TABLE 2: Measures, Variables, and Their Sources

Latent Variables	Individual Measures	Variable Description	References
Independent variable SOCIAL INFLUENCE	Customers	Customers significantly influence IT assimilation	[7, 11, 34 , 37, 46, 52]
	Competitors	Competitors significantly influence IT assimilation	[7, 11, 28, 38, 45, 49]
	Vendors	Vendors significantly influence IT assimilation	[7, 11, 41, 46, 47, 48]
	Government agencies	Government agencies significantly influence IT assimilation	[7, 11, 26, 46]
	Professional networks	Professional networks significantly influence IT assimilation	[7, 11, 26, 46]
Control variables	Top management	Top management's attitude toward incorporation of IT in the firm	[12, 24, 49, 53]
	Firm size	Actual size of the firm	[2, 49]
Mediating variable KNOWLEDGE ACQUISITION	Technology specialization	Level of IT specialization in technology evaluation, systems testing, and quality assurance	[16, 18, 25]
	Related knowledge	Proportion of people involved in running ERP-type software	[16, 18, 39 ,54]
Dependent variable SOFTWARE ASSIMILATION	Assimilation of material management software	The degree of implementation of innovations that have been adopted	[31, 32, 67]
	Assimilation of production control software	The degree of implementation of innovations that have been adopted	[31, 32, 67]
	Assimilation of supplier management software	The degree of implementation of innovations that have been adopted	[31, 32, 67]

Manufacturers Register and Greater Boston Manufacturing Partnership's database generated a dataset of companies with fewer than 500 employees. From this dataset, 655 firms from the Greater Boston area were randomly selected to receive surveys. Since the unit of analysis was the firm, only one survey was conducted per SME. The usable response rate was 20.6%.

The Greater Boston area includes SMEs in high-technology manufacturing industries, the sample was drawn from industries such as computer and electronic products, fabricated metal products, machinery, electrical equipment, and appliance and miscellaneous manufacturing. Most of the surveyed firms were categorized by North American Industry Classification System (NAICS) codes 332 and 334. The sample is consistent with the nature of the manufacturing industry in the Greater Boston region.

In SMEs, Chief Information Officer (CIO) or Chief Technology Officer (CTO) positions are rare and senior managers often undertake this responsibility, including Chief Executive Officers (CEOs). A significant proportion of the respondents belonged to senior management.

Response bias is a potential limitation of any survey. The study tested for response bias by comparing the early respondents and late respondents with respect to firm size and industry. The chi-square analysis revealed no systematic response bias. Random calls were also made to non-respondents, and unavailability of time was the most common reason for not completing the survey.

DATA ANALYSIS AND RESULTS

The research model and constructs were validated using the standard procedures appropriate for a research model with formative constructs. As our model consists of formative constructs, SmartPLS [11] was used to conduct the analysis. The latent variables in the model are all formative in nature, which obviates the need for checking for convergent and discriminant validity. For instance, according to Petter et al. [63, page 28], "This suggests that it is unlikely for one to achieve convergent validity and discriminant validity with formative constructs." Further, the authors add [page 29], "Therefore, methods of determining construct validity with reflective constructs do not apply to formative constructs. These researchers argue that there are no tests for construct validity; therefore construct validity can only be established conceptually, using Q-sorts or expert panels, rather than the use of empirical methods." Academics and practitioners working with SMEs reviewed the survey questionnaire to ensure that the indicators captured the appropriate constructs in the research model.

The broad model and solution are discussed next. In terms of total effect, as per Table 3, the dependent variable, software assimilation, has 41% of its variation explained by the control variables, 19% by knowledge acquisition, and 33% by social influence. It is not surprising that the control variables explained such a large proportion of the dependent variable. SMEs are small institutions that suffer from risks associated with small asset bases and are very dependent on the CEO/owner making all the decisions, and so the control variables of top management attitude and firm size played a dominant role in the model

The R-square value of the dependent variable, software assimilation, is 42%, providing a reasonable output for our exercise. The R-square for the mediating variable, knowledge acquisition, is poor, which is discussed later on in this section.

The correlations among the latent variables are in line with the hypothesized model.

It is customary, even in the case of formative constructs, to show the loading of the latent variables on the measures, though there is no requirement that the latent constructs only load on their measures. Table 6 provides the loadings.

The hypothesis H1 is not supported by this research. We have only two measures for the mediating variable, knowledge acquisition, and this seems to be insufficient. In the case of formative measures, it is important that all measures that count as important for the formative measure to be formed should be included [63]. That has not been the case in this research.

Limitations and Implications

This study suffers from several limitations. First, the study was conducted in the greater Boston area and most of the respondents were in high technology manufacturing. This is not a representative sample of firms in the broader United States and thus limits its generalizability. Similarly our focus was on production control software and these being complex applications that involve the whole enterprise in selection and adoption, the results of this study may not be extendable to applications that non-manufacturing and are simpler in nature. Finally, while we had about 24% response rate, there is likely to be a self-selection bias in that firms that are enthusiastic about production technologies are more likely to participate in such research.

This research establishes the role of social influence and that of knowledge acquisition in impacting technology assimilation in firms. The sources of social influence came from vendors,

Table 3: Total Effect

	ControlVariables	Knowledge	SWAssimilation	Social_Influence
ControlVariables			0.416607	
Knowledge			0.193817	
SWAssimilation				
Social_Influence		0.219848	0.336694	

TABLE 4: R-Square

	R Square
ControlVariables	
Knowledge	0.048333
SWAssimilation	0.421765
Social_Influence	

TABLE 5: Latent Variable Correlation

	ControlVariables	Knowledge	SWAssimilation	Social_Influence
ControlVariables	1.000000			
Knowledge	0.383276	1.000000		
SWAssimilation	0.535534	0.418146	1.000000	
Social_Influence	0.151798	0.219848	0.399934	1.000000

TABLE 6: Cross Loadings

	ControlVariables	Knowledge	SWAdoption	Social_Influence
Competitors_1	0.021411	0.073273	0.185195	0.432951
Customers_1	0.101526	0.157431	0.172616	0.497628
Firm_Size_Lg10	0.965711	0.346539	0.517171	0.160171
Government_1	0.035600	0.153137	0.015428	0.191267
MM_SW	0.497485	0.373176	0.931472	0.385192
PP_SW	0.478199	0.392190	0.881264	0.327974
Professional_1	0.131004	0.153010	0.011907	0.184379
RelatedKnowledge	-0.231049	-0.002663	-0.068276	0.127154
SM_SW	0.298356	0.216341	0.471070	0.110347
Specialization	0.346402	0.989702	0.404226	0.235869
Suppliers_1	-0.066463	-0.040452	-0.165849	-0.361151
Top_Mgmt_1	0.142196	0.144462	0.076150	-0.030183
Vendors_1	-0.080641	-0.081541	-0.312754	-0.686607

TABLE 7: Path Coefficient and Variances Explained

Social Influence □ Software Assimilation	0.294. This is significant at .000 level.	H3 is supported
Knowledge Acquisition □ Software Assimilation	0.194. This is significant at .002 level.	H2 is supported
Social Influence □ Knowledge Acquisition	0.220 This is significant at .085 level.	H1 is not supported
R-square: 42.16%		

competitors, customers, government agencies and professional networks. These social actors in the environment play different intermediary roles. This study highlights the importance of these social actors for SMEs. Brown and Lockett [13] identified three types of intermediary roles: technology, enterprise, and community. Reinforcing each of these roles may help the social influence factor come into play in a positive way for the firms. SMEs are in real need of guidance regarding size-appropriate technological solutions. The current literature and public domain does not provide any size-appropriate technology solutions. The technology intermediary role can be played by vendors such as Oracle, Microsoft, and SAP, who need to develop solutions that are appropriate for SMEs. Size-appropriate solutions need to be customized and sold to firms. This role belongs to the enterprise intermediary, whose responsibility is to provide consultancy and application services. Government agencies and vendors need to play their own roles in order to make this sector competitive. Since small firms and micro-firms are not extensively connected to professional and personal networks, it is incumbent on public-sector agencies to provide the necessary knowledge and support. Lastly, SMEs are often a victim of being part of small and dense communities, and these communities should step up their advisory and assistance roles in support of SMEs.

CONCLUSION AND FUTURE RESEARCH

Firm-level analysis for IT adoption and assimilation has gained acceptance in some recent studies [32, 48, 54, 57, 73]. Diffusion studies at the industry level are also becoming popular. Each firm is embedded within the institutional environment of a cluster, and the cluster characteristics have an impact on the firm as well as the institutions. Clusters are critical masses of firms located in a geographically concentrated area that become a source of enduring competitive advantage. It is therefore appropriate to conduct research into the nature and characteristics of these clusters and the extent to which they promote and inhibit the firm-level assimilation of technologies. A question of interest: How are clusters structured, and to what extent?

This research highlights the factor of social influence as it impacts the assimilation of technology of small and medium firms. The social influence may be exerted through multiple intermediary roles that different institutions play for SMEs to be competitive in the global economy; future research should focus on the role of intermediaries in promoting SME-specific solutions and technologies. Such research would delineate the roles that institutions such as government agencies and professional networks need to play in order to enhance the competitiveness of SMEs world-wide.

Information systems research has focused on inhibitors and promoters of technology adoption, especially where individual technologies are involved. Since SMEs are major contributors to GDP and employment, future empirical studies should be conducted focusing on technologies that are important to the entire value chain. Finally, this research model was developed

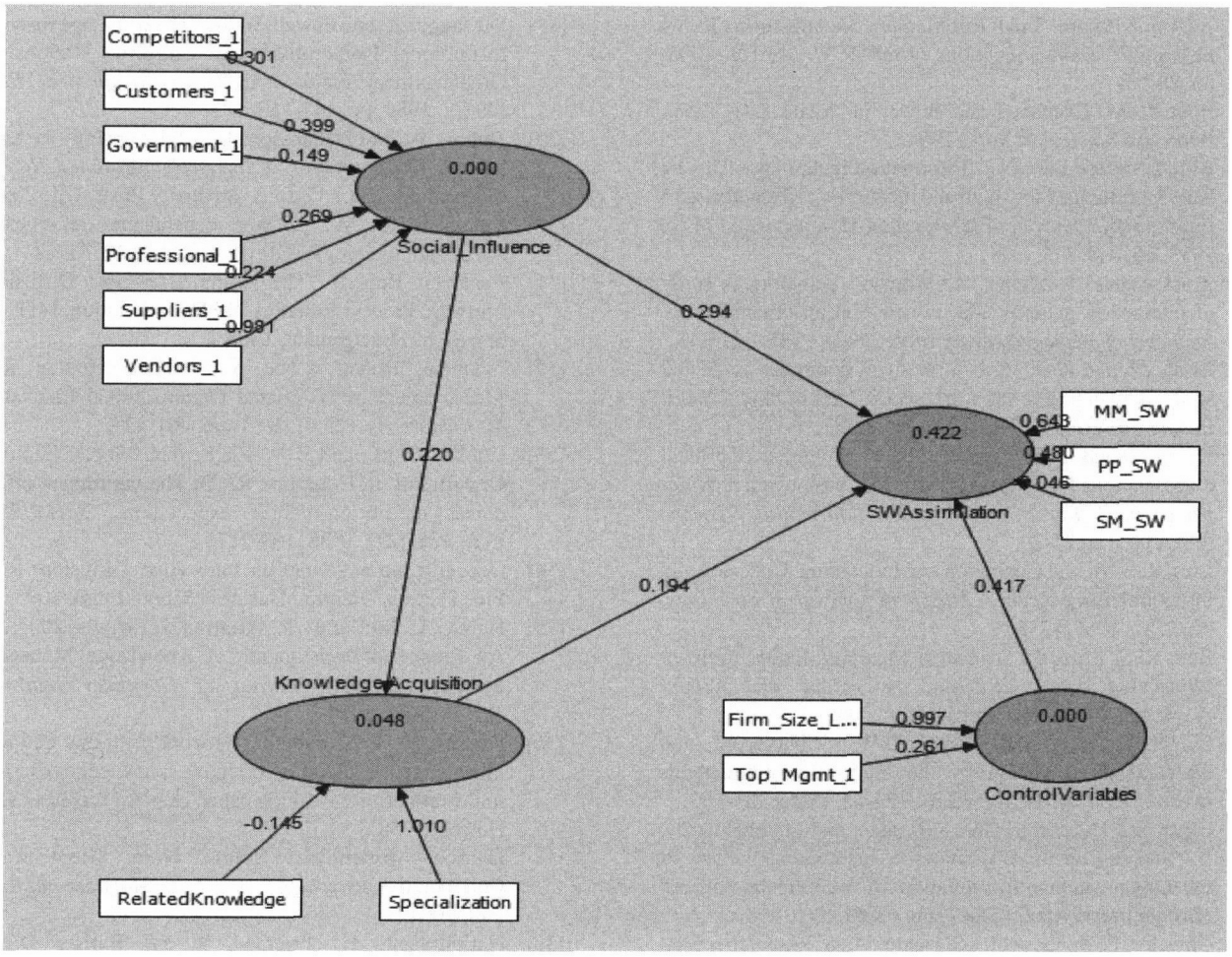

FIGURE 2: Structural Equation Analysis of the Research Model

specifically for SMEs, but it might be interesting to investigate its applicability to larger firms. This might also provide a better understanding of where managerial intervention should be directed.

REFERENCES

[1] Adler, Paul and Seok-Woo Kwon. "Social Capital: Prospects for New Concepts," *Academy of Management Review*, (27:1), 2002, 17-40.

[2] Aiken M. and Hage, J. "The Organic Organization and Innovation," *Sociology*, (5), 1991, pp. 63-82.

[3] Alpar, P. and Reeves, S. "Predictors of MS/OR applications in small businesses," *Interfaces*, (20:2), 1990, pp. 2-11.

[4] Attewell, Paul. "Technology Diffusion and Organizational Learning: The case of Business Computing," *Organizational Science*, (3:1), 1992, pp. 1-19.

[5] Autio, E., H. J. Sapienza and J. Almeida. "Effects of age at entry, knowledge intensity, and imitability on international growth," *Academy of Management Journal*, (43), 2000, 909-924.

[6] Barney, Jay B. "Firm Resources and Sustained Competitive Advantage," *Journal of Management*, (17), 1991, 99-120.

[7] Beck, Thorsten, Demirguc-Kunt, Asli and Maksimovic. Vojislav. "Financial and Legal Constraints to Growth: Does Firm Size Matter?" *Journal of Finance*, (60:1), 2005, pp. 137-178.

[8] Bharati, P. and Chaudhury, A. "Current Status of Technology Adoption: Micro, Small and Medium Manufacturing Firms in Boston", *Communications of the ACM*, (49:10), 2006, pp. 88-93.

[9] Blau, P. M."Exchange and Power in Social Life," *John Wiley and Sons*, New York, 1964.

[10] Blili, S. and Raymond, L. "Information Technology: Threats and Opportunities for small and medium-sized enterprises," *International Journal of Information Management*, (13:6), 1993, pp. 439-448.

[11] Brass, Daniel J. "Men's and Women's networks: A study of interaction patterns and influence in an organization," *Academy of Management Journal*, (28:2), 1985, 327-343.

[12] Bridge, J. and Peel, M. J. "A study of computer usage and strategic planning in the SME sector," *International Small Business Journal*, (17:4), 1999, pp. 82-87.

[13] Brown, David H. and Lockett, Nigel. "Potential of critical e-applications for engaging SMEs in e-business: a provider perspective," *European Journal of Information Systems*, (13), 2004, pp.21-34.

[14] Burt, R. S."Social Contagion and Innovation: Cohesion and Structural Equivalence," *American Journal of Sociology*, 92, 1987, 1287-1335.

[15] Burt, R. S. *Toward a Structural Theory of Action: Network Models of Social Structure, Perception, and Action*, Academic Press, New York, 1982.

[16] Campbell, D,T, and Fiske, D,W. "Convergent and discriminant validation by the multi-trait-multimethods matrix," *Psychological Bulletin*, (74, 2), March, 81-105.

[17] Chatterjee, Debabroto, Grewal, Rajdeep and Sambhamurthy, V. "Shaping up for E-Commerce: Institution Enablers of the Organizational Assimilation of Web Technologies," *MIS Quarterly*, (26:2), 2002, pp. 65-89.

[18] Chwelos, P., Benbasat, I. and Dexter, A., S. Research report: Empirical test of an EDI adoption model. *Information Systems Research* (12:3), 2001, pp. 304-321.

[19] Clemons, E. K. "MAC-Philadelphia National Bank's Strategic Adventure in Shared AMT Networks," *Journal of Management Information Systems*, (7:1), 1990, pp. 5-25.

[20] Coleman, J., Menzel Katz. *Medical Innovation: A diffusion study*, Bobs-Merrill Co., Indianapolis, 1996.

[21] Cragg, P. B. and King, M. "Small-Firm Computing: Motivators and Inhibitors," *MIS Quarterly*, (17:1), 1993, pp. 47-60.

[22] Dandridge, J. C. "Children are not small grown-ups- Small businesses need their own organizational theory," *Journal of Small Business Management*, (17:2), 1979, pp. 53-57.

[23] Damanpour, F. "Organizational Innovation: a Meta-analysis of effects of determinants and moderators," *Academy of Management Journal*, (34), 1991, pp. 555-590.

[24] Dei Ottati, G. "Rust, interlinking transactions and credit in the industrial district," *Cambridge Journal of Economics*, (18), 1994, pp. 529-546.

[25] DeLone, W. H. "Determinants of success for computer usage in small businesses," *MIS Quarterly*, (12:1), 1988, pp. 51-61.

[26] Dewan, S., Michael, S., and Min, C. "Firm Characteristics and Investments in Information Technology: Scale and Scope Effects," *Information Systems Research* , (9:3), 1998, pp. 219-232.

[27] DiMaggio, P. J. "Interest and Agency in Institutional Theory," in *Institutional Patterns and Organizations*, L. G. Zucker (ed.), Ballinger, Cambridge, 1988, pp. 3-22.

[28] DiMaggio, P., and Powell, W. W. "The Iron Cage Re-visited: Institutional Isomorphism and Collective Rationality in Organizational Fields," *American Sociological Review*, (48:2), 1983, pp. 147-160.

[29] Dubois, A. and Hakansson, H. "Relationships as Activity Links," *The Formation of Inter-Organizational Networks*, in Ebers, M. (Ed.) Oxford University Press, UK, 2002.

[30] Emerson, R. M., "Power dependence relationships," American Sociological Review, (27), 1962, 31-41.

[31] Fichman, Robert. "The Assimilation and Diffusion of Software Process Initiative," PhD Dissertation, MIT, Sloan School of Management, 1995.

[32] Fichman, Robert. "The role of Aggregation in the Measurement of IT-Related Organizational Innovations," *MIS Quarterly*, (25:4), 2001, pp. 401-429.

[33] Gabbay, S. M., and E. W. Zuckerman."Social Capital and Opportunity in Corporate R&D: The contingent effect of contact density on mobility expectations," *Social Science Research*, (27), 1988, 189-217.

[34] Gourville, John. "Note on Innovation Diffusion: Rogers' Five Factors," Harvard Business School Press, 2005.

[35] Halawi, L., McCarthy, R., Aronson, J., (Winter, 2007 2008), An Empirical Investigation of Knowledge Management Systems Success, *Journal of Computer Information Systems* 48(2), 121-135

[36] Hansen, M. T. "Combining network centrality and related knowledge: Explaining effective knowledge sharing in multi-unit firms," Working paper. Harvard Business School. Boston, 1988.

[37] Hanson, Morten and Nohria, Nitin. "How to build Collaborative advantage," *MIT Sloan Management Review*, Fall, 2004.

[38] Harindranath, G., Dyerson, R. and Barnes, D. "ICT adoption and use in UK SMEs", Proceedings of the

European Conference on Information Management and Evaluation, Conservatoire National des Arts et Metiers (CNAM), Montpellier, France, 2007.

[39] Haveman, H. A. "Follow the Leader: Mimetic Isomorphism and Entry into Markets," *Administrative Science Quarterly*, (38:4), 1993, pp. 593-627.

[40] Haunschild, P. R. and Miner, A.S. "Modes of Interorganizational Imitation: The Effects of Outcome and Salience and Uncertainity," *Administrative Science Quarterly*, (42:4), 1997, pp. 472-500.

[41] Hsu, Chin-Lung and Judy Chuan-Chuan Lin. "Acceptance of blog usage: The roles of technology acceptance, social influence and knowledge sharing motivation," *Information & Management*, (45), 2008, 65-74.

[42] Iacovou, C. L., Benbasat, I., and Dexter, A. S. "Electronic Data Interchange and Small Organizations: Adoption and Impact of Technology," *MIS Quarterly*, (19:4), 1995, pp. 465-485.

[43] Igbaria, M., Zinatelli, N., Craig, P. B. and Cavaye, A. L. M. "Personal Computing Acceptance Factors in Small Firms: A Structural Equation Model," *MIS Quarterly*, (21:3), 1997, pp. 279-305.

[44] Jarvenpaa, S. L. and Ives, B. "Executive Involvement and Participation in the Management of Information Technology," *MIS Quarterly*, (15:2), 1991, pp. 205-227.

[45] Kim, H. W., Chan, H. C., Gupta, S. "Value-based Adoption of Mobile Internet: An empirical investigation," *Decision Support Systems* (43:1), February, 2007, pp. 111-126.

[46] Kimberley, J. R., and Evanisko, M. J. "Organizational Innovation: The Influence of Individual, Organizational, and Contextual factors on Hospital Adoption of Technical and Administrative Innovations," *Academy of Management Journal*, (24:4), 1981, pp. 689-713.

[47] King, J. L., Gurbaxani, V., Kraemer, K. L., McFarlan, F. W., Raman, K. S., and Yap, C. S. "Institutional Factors in Information Technology Innovation," *Information Systems Research*, (5:2), 1994, pp. 139-169.

[48] Kishore, R. and McLean, E. R. "Reconceptualizing innovation compatibility as organizational alignment in secondary IT adoption contexts: an investigation of software reuse infusion," *IEEE Transactions on Engineering Management* (54:4), 2007, pp. 756-775.

[49] Knudsen, S. E., Walton II, J. K., and Young, F. M. "Business-to-Business Payments and the role of Financial Electronic Data Interchange," *Federal Reserve Bulletin*, (80:4), 1994, pp.269-278.

[50] Kraatz, Mathew S., "Learning by Association? Inter-organizational networks and adaption to environmental change." *Academy of Management Journal*, (41), 1998, 621-643.

[51] Kulviwat, Songpol, Gordon C. Bruner II and Obaid Al-Shuridah, "The role of social influence on adoption of high tech innovations: The moderating effect of public/ private consumption," *Journal of Business Research*, (62), 2009, 706-712.

[52] Levy, M., Powell, P, and Yetton, P. "The Dynamics of SME Information Systems," *Small Business Economics* (19), 2002, pp. 341-354.

[53] Little, A. D. *The Manufacturing Report*, Lionheart Publishing, Marietta, GA, 1988.

[54] Liang, H., Saraf, N., Hu, Q., and Xue, Y. "Assimilation of enterprise systems: The effect of external institutional pressures and the mediating role of top management," *MIS Quarterly*, (31:1), 2007, pp. 1-28.

[55] Mahler, Alwin, and Rogers, Everett, M. "The Diffusion of Interactive Communication Innovation and the Critical Mass: The Adoption of Telecommunication Services by German Banks," *Telecommunication Policy*, (23), 1999, pp. 719-740.

[56] Markus, M. L. "Toward a Critical Mass Theory of Interactive Media: Universal Access, Interdependence, and Diffusion," *Communication Research* (14:5), 1987, pp. 491-511.

[57] Mathiassen, L. and Pries-Heje, J. Business Agility and Diffusion of Information Technology, *European Journal of Information Systems* (15), 2006, pp. 116–119.

[58] McDougall, P. P., S. Shane and B. M. Oviatt."Explaining the formation of international new ventures: the limit of theories from international business research," *Journal of Business Venturing*, (9), 1994, 469-487.

[59] Meyer, A. D. and Goes, J. B. "Organization Assimilation of Innovation: A Multilevel Contextual Analysis," *Academy of Management Journal*, (31:4), 1988, pp. 897-923.

[60] Mohr, M. K., and Morse, E. V. "Size, Centralization and Organizational Adoption of Innovations," *American Sociological Review*, (42:5), 1977, pp. 716-725.

[61] Mytinger, Robert E. "Innovations in Local Health Services: A study of Adoption of New Programs by Local Health Departments with particular references to new health practices," Division of Medical Care Administration, Public Health Services, U.S. Department of Health, Education, and Welfare, Washington, D.C., 1968.

[62] Nahapiet, Janine and Sumantra Ghoshal, Social Capital, Intellectual Capital and the Organizational Advantage, *Academy of Management Review*, (23:2), 1998, 242-268.

[63] Petter, Stacie, Detmar Straub and Arun Rai. "Specification and Validation of Formative Constructs in IS Research," Working Paper, Georgia State University, 2003.

[64] Podolny, J. M. & K. L. Page, "Network forms of organization," *Annual Review of Sociology*, (24), 1988, 57-76.

[65] Powell, W. W., and L. Smith-Doerr, "Networks and economic life," in N. J. Smelser and R. Swedberg (Eds.), *The Handbook of Economic Sociology*, (368-402), Princeton, Princeton University Press, 1994.

[66] Prananto, A., McKay, J., and Marshall, P. "The Spectrum of e-Business Maturity in Australian SMEs: A Multiple Case Study Approach to the Applicability of the Stages of Growth for e-Business Model," Proceedings of the 11th European Conference on Information Systems (ECIS), 2003.

[67] Rogers, E. M. *Diffusion of Innovations*, Free Press, New York, 1995.

[68] Rogers, E. M. *Diffusion of Innovations*, Free Press, New York, 2005.

[69] Son, J-Y, and Benbasat, I. "Organizational adoption and the use of B2B electronic market places: Efficiency and legitimacy-oriented perspectives," University of British Columbia, Vancouver, 2004.

[70] Senn, J.A. and Gibson, V. R. "Risks of investment in microcomputers for small business management," *Journal of Small Business Management*, (19:3), 1981, pp. 24-32.

[71] Spender, J. C., "Making knowledge the basis of a dynamic theory of the firm," *Strategic Management Journal*, Winter

Special Issue, (17), 1996, 45-62.
[72] Straub, D.W. "Validating instruments in MIS research," *MIS Quarterly*, (13:2) June, 1989, pp. 147-169.
[73] Teo, H. H., Wei, K. K. and Benbasat, I. "Predicting Intention to Adopt Inter-organizational Linkages: An Institutional perspective," *MIS Quarterly*, (27:1), 2003, pp. 19-49.
[74] Thong, James Y. L., Yap, C. S., and Raman, K. S. "Engagement of External Expertise in Information Systems Implementation," *Journal of Management Information Systems*, (11:2), 1994, pp. 209-231.
[75] Thong, James Y. L., Yap, C. S., and Raman, K. S. "Top Management Support, External Expertise and Information Systems Implementation in Small Businesses," *Information Systems Research*, (7:2), 1996, pp. 248-267.
[76] Thong, James Y. L. "An Integrated Model of Information Systems Adoption in Small Businesses," *Journal of Management Information Systems*, (15:4), 1999, pp.187-214.
[77] Thong, Yu, Hock-Hai Teo, and Chuan-Hoo Tan. "Direct and Indirect Use of Information Systems in Organizations: An Emperical Investigation of System Usage in a Public Hospital," Proceedings of the Twenty Ninth International Conference on Information Systems, Paris, 2008.
[78] Tsai, W. and S. Ghoshal. "Social Capital and value creation: The role of inter-firm networks," *Academy of Management Journal*, (41), 1998, 464-478.
[79] Utterback, J. M. "Innovation in Industry and the Diffusion of Technology," *Science*, (183), 1974, pp. 620-626.
[80] Venkatesh, V., Morris, M. G., Davis, G. B., Davis, F. D. "User Acceptance of Information Technology: Toward a Unified View," *MIS Quarterly* (27: 3), September, 2003, pp. 425-478.
[81] Webster, J. "Networks of Collaboration or Conflict? Electronic Data Interchange and Power in the Supply Chain," *The Journal of Strategic Information Systems*, (4:1), 1995, pp. 31-42.
[82] Yap, C. S., Soh, C. P. P. and Raman, K. S. "Information Systems Success Factors in Small Business," *Omega*, (20), 1992, pp. 577-609.
[83] Y-Li, Helena, Erkko Autio and Harry J. Sapienza. "Social Capital, Knowledge Acquisition, and Knowledge Exploitation in Young Technology-based firms," *Strategic Management Journal*, (22), 2001, 587-613.
[84] Zhu, Kevin, Kenneth Kraemer, Sean Xu. "Electronic business adoption by European firms: a cross-country assessment of facilitators and inhibitors," *European Journal of Information Systems*, (12), 2003, 251-268.
[85] http://web.sba.gov/faqs/faqIndexAll.cfm?areaid=24 U.S. Small Business Administration. (2010). Retrieved April 29, 2010