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IT Adoption in Small and Medium-Sized Enterprises: The Role of Knowledge Acquisition

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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 square 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. Data has been collected and is currently being analyzed. Results would be discussed at the conference.

Keywords

Innovation, adoption, assimilation, social exchange theory, intermediaries.

INTRODUCTION

The accepted 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.¹

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 [58], Podolny and Page [57], and Adler and Kwon [1] have observed the impact of social interactions in helping firms acquire new skills and technologies. Fichman [27] 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. [48] related absorptive capacity, again measured in terms of knowledge acquired by the firm, to technology adoption in the field of enterprise resource planning systems.

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

¹ <http://web.sba.gov/faqs/faqIndexAll.cfm?areaid=24> [last accessed on 1/15/2010]

adoption. Our model is described in

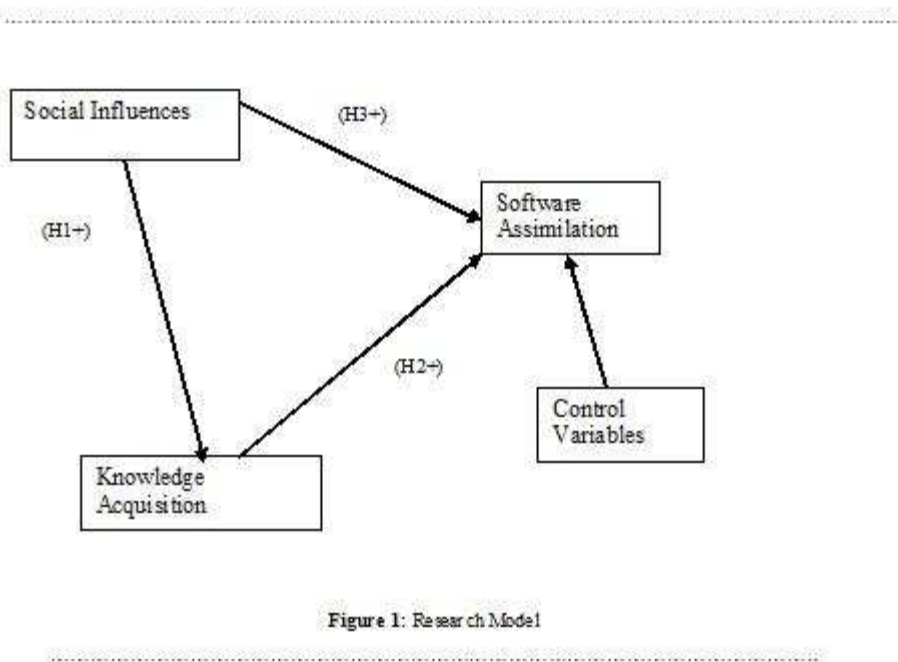


Figure 1.

IT research on technology adoption for small and medium firms has been limited to the study of motivators and inhibitors [20], acceptance and impact [37,38], factors relating to satisfaction and success [22], implementation issues [64, 65], and maturity issues [59]. Thong [66] 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 [66] 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 [66] have been used as control variables in our research in order to isolate the effect of social influence on the firm.

The rest of the paper is organized as follows: The next section sets out the research model. It is followed by a section describing the conditions and context in which this research was carried out. Managerial implications, possible directions of future research, and preliminary 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) [30, 62]. 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 [29], firms are subject to coercive, normative, and mimetic forces from others in their environment. In social exchange theory, power and trust [9, 26] 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 [55]. Such inter-firm networks are a major source of information and knowledge among firms [72]. Small firms, as they are resource-constrained [52], 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 [55], 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 [36], Tong et al. [67], and Kulviwat et al. [45] have related social influence to technology usage, innovation, and adoption.

Social Influence → Knowledge Acquisition

According to Adler and Kwon [1], 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 [12, 14, 19, 59]. 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 [14] focuses on entrepreneurs who use this influence in networks to find business opportunities.

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. [43] and Webster [70] related the effects on industry of pressure from large customers, such as GM and Ford respectively. Teo et al. [63] 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 [35] 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 [24] and helps minimize experimentation costs in an environment of uncertainty [46]. These influences are akin to forces of contagion in social capital theory. Thong [65] found competition to have a positive effect on IS assimilation in small firms. Haveman [34] and Clemon [18] pointed to an imitation effect in firm behavior in the airline and banking industry. In the context of ERP systems, Liang et al. [48] found that competitors have a role; Son and Benbasat [61] found the same for B2B systems, and Teo et al. [63] for electronic data interchange (EDI).

According to DiMaggio and Powell [24], pressures are manifested through firm-supplier relationships. Burt [14] and Markus [50] pointed to pressures from a dyadic channel composed of suppliers, vendors, and other intermediaries. Teo et al. [63] 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. [65] found that vendors and consultants played an important role in IS implementation.

Organizational decision-makers are affected by norms and standards that are institutionalized in their environments, such as business and professional circles [24]. Such influences by professional networks are related to prominence in social capital theory [25]. King et al. [41] and Teo et al. [63] found evidence that participation in industry and trade associations and with government-sanctioned bodies constitutes pressure on a firm. Rogers [60 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 [27]. Having a greater variety of specialists gives a firm an enhanced knowledge base, and Fichman [27] 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. [48]. 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 [27]. Such innovations have been seen to result from knowledge variety and specialization in the firm. For instance, Kimberely and Evanisko [40] ascribed the innovativeness of organizations to specialization in related activities, and Rogers [60] 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 [40]. 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 [28] related social capital to innovation in R & D. Hansen [31] observed that network relationships among firms promoted knowledge sharing. Tsai and Ghoshal [68] and Nahapiet and Ghoshal [55] 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 [27] 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 [36] show that acceptance of blogging technology is dependent on social influence and knowledge sharing in the network; Tong et al. [67] relate information systems usage in hospitals to social influences in the social environment of a hospital; and Kulviwat et al. [45] 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 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 [60] and Fichman [27]. The assimilation stage of technology is aggregated over the three software systems. Rogers [60] 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 [27] listed six assimilation stages: not aware, aware, interest, evaluation/trial, commitment, limited deployment, and general deployment. 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. This technology cluster adoption and assimilation model maps to the theory of Rogers [60]; 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. [56] 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 [56].

Brass [10] 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 [10], 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 [27].

Technology Specialization: According to Kimberley and Evanisko [40], 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 [27], an existing state of related knowledge facilitates absorption of new knowledge. Following Fichman [27], 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 [60], 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 [54, 69]. Mytinger [54] provided evidence that firm size is one of the most important variables explaining innovativeness. Mahler and Rogers [44] 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 [66].

Top Management Attitude: The IS research literature is replete with evidence that top management’s support is crucial for technology adoption. Jarvenpaa and Ives [45] and Chatterjee et al. [16] 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. [71] and Thong [66], in the case of an owner-CEO who is often the top management for a small firm. Thong et al. [65] provided an extensive list of references showing the positive relationship between top management support and IT adoption.

Table 1: Measures, Variables, and Their Sources

Latent Variables	Individual Measures	Variable Description	References
<i>Independent variables</i> SOCIAL INFLUENCE	Customers	Customers significantly influence IT assimilation	[7, 10, 29, 32, 40, 46]

Latent Variables	Individual Measures	Variable Description	References
	Competitors	Competitors significantly influence IT assimilation	[7, 10, 24, 33, 39, 43]
	Vendors	Vendors significantly influence IT assimilation	[7, 10, 36, 40, 41, 42]
	Government agencies	Government agencies significantly influence IT assimilation	[7, 10, 23, 40]
	Professional networks	Professional networks significantly influence IT assimilation	[7, 10, 23, 40]
<i>Control variables</i>	Top management	Top management's attitude toward incorporation of IT in the firm	[11, 21, 43, 47]
	Firm size	Actual size of the firm	[2, 43]
<i>Mediating variable</i> KNOWLEDGE ACQUISITION	Technology specialization	Level of IT specialization in technology evaluation, systems testing, and quality assurance	[15, 17, 22]
	Related knowledge	Proportion of people involved in running ERP-type software	[15, 17, 34, 48]
<i>Dependent variable</i> SOFTWARE ASSIMILATION	Assimilation of material management software	The degree of implementation of innovations that have been adopted	[27, 60]
	Assimilation of production control software	The degree of implementation of innovations that have been adopted	[27, 60]
	Assimilation of supplier management software	The degree of implementation of innovations that have been adopted	[27, 60]

METHODOLOGY

After searching the literature in the theory domain, constructs were developed that generated sample items. A pilot study was conducted with randomly selected SMEs in order to assess the reliability and validity of the constructs. Since the unit of analysis was the firm, only one survey was conducted per SME. A dataset was compiled from Massachusetts Manufacturers Register and the Greater Boston Manufacturing Partnership database. 655 firms from the Greater Boston area were randomly selected to receive surveys. The study had a response rate of 24.1%.

PRELIMINARY CONCLUSIONS

Firm-level analysis for IT adoption and assimilation has gained acceptance in some recent studies [27, 42, 48, 51, 63]. 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 model was developed specifically for SMEs, but it might be interesting to investigate its applicability to larger firms. In the case of larger firms, a comparison of firm characteristics with institutional actors might provide important insight. This might also provide a better understanding of where managerial intervention should be directed. The results from data analysis will be presented at the conference.

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