

An Investigation of Leadership Determinants for Technological Service Adopters using Discriminant Analysis

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This study examines the adoption propensity of 379 randomly selected American firms. Inquiry is made regarding organizational and managerial determinants of these firms. Two primary questions are addressed. Can the categorization of technology adopting firms be classified? Second and foremost, which determinants are the most effective in differentiating between the adopters and non-adopters of technology service innovations? Using a classification analysis and step-wise discriminant analysis, the research suggests that a firm's propensity to adopt service innovations can be correctly predicted better than chance and further identifies which determinants significantly associate with propensity membership.

INTRODUCTION

The adoption and diffusion of innovations is a subject that has been widely studied across a broad spectrum of disciplines, including social science, marketing, engineering and management. While the literature on innovations and their adoption by organizations is extensive (Rogers, 1983), relatively few studies focus on high technology. Since the early computerization of accounting transactions in the 1950s, high-technology innovations have become increasingly common in industrial organizations. And while substantial literature exists on organizational innovation in general, it has only recently been extended to technological innovations in particular (Tornatsky and Fleischer, 1990).

A similar situation has evolved with regard to inquiry on the marketing issues related to these innovations. As noted by Jackson et al. (1995), marketing to industry is essentially different from marketing to consumers. The organizational buying process is more complex, takes place over a longer period of time, and is influenced by a greater number of forces both inside and outside the buyer firm (Gupta and Rogers, 1991).

Not only has there been a void in the adoption patterns of technology services in the literature, there has also been an obvious omission of any sophisticated statistical approaches to the analysis of adoption propensity patterns or adoption rates to revenue performance.

Therefore, the intent of this study is to (1) examine various frequencies and descriptives of technology service adoption; (2) confirm that the innovation adoption of technology services can

be classified; and (3) identify managerial determinants that influence the adoption of technological services.

THEORETICAL UNDERPINNINGS

There are numerous studies in the literature regarding typical product adoption patterns, however technological innovation literature is less replete. Foster (1982) suggests that different approaches are necessary when adopting discontinuous innovations. Moore (1995), for example contends that the appropriate approach to high-tech marketing should be focused more on the solution the technology provides rather than the technology's feature and benefits. Furthermore, the service component of the technology product must highlight value added, visible to late adopters, if wide spread adoption is to occur.

Simpson and Docherty (2004) offer specific rationale explaining the reasons for barriers to technology adoption in small and medium sized organizations. The internal barriers include: management resistance; technology concerns; resource issues; lack of awareness; and lack of information, and market orientation. This final barrier, market orientation has had notable research over the last 20 years, (Kohli and Jaworski 1990; Narver and Slater 1990), while work by Chang and Chen, (1998) addressed technological innovation in the service sector.

Chong (2001) provides insight into the external environment factors likely to influence the adoption of technology oriented products. These include: government influences; environmental uncertainty; issues related to infrastructure; pressure from trading partners; industry-specific competitive pressures; critical mass; and accepted industry standards. In markets where competition is fierce, elasticities of demand are going to be higher due to the availability of close substitutes, therefore having the ability to control future innovative behaviors within the firm (Majumdar and Venkataraman, 1993).

The diffusion of technology does not occur at a similar rate to tangible products. There are several general models that address this phenomenon. The first model speaks to the amount of information that exists with the technology and how easily it can become available. The second model deals with the technology's differences, goals and capabilities. The final model examines density dependence that considers diffusion as the result of legitimization and competition (Rogers, 1995).

Perceptions of innovation characteristics and socioeconomic characteristics have been asserted as determinants of technological innovation adoption (Gatignon and Robertson, 1985; Labby and Kinnear 1985). Davis (1989) contends that the decision to use a new technology is determined by the extent to which the consumer believes it is cost effective, either with goods or services. Perceived benefits of are conceptually analogous to relative advantage, defined as "the degree to which an innovation is perceived better than the idea it supersedes" (Rogers 1985; p.212). Past studies have found that relative advantage has a significant impact on the adoption rates of many technological innovations (Tornatzky and Klein, 1982).

Recent Studies of Firm-Based Innovation Adoption

In a 2003 study, Wu, Mhajan and Balasubramanian found top management emphasis, learning ability, customer power, and normative pressures to be significant antecedents, with predictive value for e-business adoption in communication. They also found that in internal administration, customer orientation and normative pressures are two significant antecedents to e-business. For online order taking, the significant antecedents were top management emphasis

and normative pressures. An organization's learning ability and normative pressures were found to be significant antecedents of e-procurement. (Wu, 2003)

Another study of the adoption of electronic commerce in New Zealand businesses "found what amounts to evidence of an incipient and exploitation of EC technology on a local level. The study concluded that firms that adopt and those that do not adopt EC technologies are separated by a number of significant differences. Among these differences is the adopters' trend to be more proactive, more aware of the various opportunities afforded by new technology, more centered on the customer and more receptive to changes taking place in customer/competitive environments. Non-adopters were found to have negative attitudes towards EC, the prevailing belief being that numerous barriers exist preventing them from selling their goods and services online. These companies are also slower in detecting changes in technologies that might have an effect on the firms' business." (McCole, 2005, p.36)

Slow adoption of a product has been linked to high introductory prices and uncompetitive products of low quality or that insufficiently innovative. A company may also be slow in adopting a product due to failure to develop niche markets. Consumer resistance to an innovation is another reason, and this can happen because of a conflict between innovation, on the one hand, and consumers' ingrained belief structures, which requires acceptance of unfamiliar routines or the abandonment of deep-rooted traditions.

Researchers down under have discovered significant statistical evidence to point to a positive relationship between awareness of innovation and the influence of the vendors of B2B trading exchanges in the context of small businesses in western Australia. The study found that organizational characteristics of a small business are likely to exert an influence on the business' attitude towards adopting a B2B trading exchange. The study confirmed that awareness is a significant perception or belief factor. Specifically, it found that awareness of an innovation is influenced by the external factor that is the vendors of an innovation. (Quaddus, 2007)

Two types of institutional forces, coercive and normative, have significant influence on attitude and intention to use Internet banking. The results indicate that IB can benefit from social influences that could result in potential customers jumping onto the IB bandwagon. In order to create normative expectations, banks may need to construct an IB user base and conduct referral champions. With respect to coercive forces, banks can make certain services available only on the Internet and "provide inducements" for IB users. Banks may also work with other businesses, such as furniture stores, online stores, and mortgage brokers. Subsequently, when customers use services provided by these companies, they may be required to use the IB services associated with those businesses. (Shi, 2008)

A study of IT adoption by Chinese companies found that government can have a significant influence on firms' IT infrastructure construction and management, but it cannot directly influence firms' IT usage. The value creation process of firms' informatization may be thought of in several phases. The first phase is that of IT infrastructure construction. Companies use IT application systems to support their business and management, thus realizing the value of IT. Not unexpectedly, management has an important role in a company's IT usage. (Cui, 2008)

Brand (2008) completed an examination of factors impacting e-commerce adoption in small and medium-sized enterprise, the authors pointed out that explicit knowledge plays a much more important role when the innovation is new to the company than when the company has accumulated hands-on experience with the innovation. One can therefore conclude that knowledge more weakly linked to adoption intention for firms at the advanced level. The same is true of satisfaction.

Lastly, Simpson (2004) analyzed e-commerce adoption among SME's in the UK, the following findings were made: Internal pressures, such as those from family and friends, seemed to be more significant determinants of adoption than competitive pressures. "E-commerce adoption was credited with the ability of rescuing struggling businesses. The study found that SMEs need support and advice for e-commerce and government, while having an opportunity to exploit the demand, may be reluctant to do so or is otherwise burdened by the bureaucracy inspired by the old Business Link formula. (Simpson, 315)

Behavioral Determinants of Decision Making

The behavioral theory of the firm was developed by Cyert and March (1963), furthering earlier work by Simon (1955, 1959). This theory is an interpretation and explanation of how businesses make economic decisions. Cyert and March believe that a firm's behavior reflects the managers who control the firm. Individual decision-makers pursue different goals for different purposes. Decision constraints lead to alternative choices and expected outcomes. Decisions made by managers vary depending on the particular situation (Anderson, 1982). Four components from the behavioral theory of the firm are used for the basis of this study. These components are commonly cited characteristics of internal activities and motivations driving innovation adoption.

First suggested in the behavioral theory of the firm is the awareness of firm competencies and advantages. Specifically, managerial awareness about the organization's differential advantages acts as a catalyst for decision behavior. Particular advantages studied include the firm's product, managerial knowledge, sales volume, and firm size (employees, assets, or sales). The second component of the theory states that aspiration levels of management are a primary element of organizational behavior. Studies (Siegel, 1957; Atkinson, 1957; Cyert and March, 1963) empirically associate varying levels of risk-taking and aggressiveness by decision makers of the firm with managerial aspirations. The third general determinant category derived from the behavioral theory of the firm is management's expectation of business activity. Cyert and March (1963) further assert that expectations directly influence behavior. Early empirical work regarding expectations focused on profitability, growth, and their relationship in determining innovation adoption outcomes.

The final component derived from the behavioral theory of the firm is resource allocation, more commonly referred to as managerial commitment. Managerial commitment often determines organizational behavior in several areas, such as budgetary focus, search behavior, uncertainty avoidance and organizational learning. The independent variables used in this study reflect the behavioral drivers primarily established from the theory of the firm (see Table 1). Studies continue to follow the foundational works cited here.

As a precursor for decision making and risk taking, Cyert and March's work, along with others, has continued to be examined in the context of organization expansion and best practice behavior. The characteristics displayed by organizational leaders suggest a common underpinning of behavior that all successful and influential leaders display, with respect to organizational development and expansion. Although the innovation adoption literature is substantive, few studies have examined the managerial motivations of behavior in a contemporary context with the Theory of the Firm.

TABLE 1
INDEPENDENT VARIABLES

DIFFERENTIAL FIRM ADVANTAGES	
Unique Product	DA_UP
Management Strength	DA_MS
Capital Investment	DA_CI
Sales Volume	DA_SV
Employee Size	DA_ES
MANAGERIAL ASPIRATIONS	
Aspirations for Growth	A_G
Aspirations for Profit	A_P
Aspirations for Efficiency	A_E
Aspirations for Security of Markets	A_SM
MANAGERIAL EXPECTATIONS	
Expectations for Growth from Innovation	E_GI
Expectations for Profit from Innovation	E_PI
Expectations for Efficiency from Innovation	E_EI
Expectations for Security of Markets from Innovation	E_SMI
MANAGERIAL COMMITMENT	
Commitment to New Business Processes	C_NBP
Commitment to Expanding Market Share	C_EMS
Commitment to Development of New Markets	C_DNM
Commitment to a Formal Innovation Adoption Policy	C_FIP
Commitment to being an Early Adopter	C_EA

METHODOLOGY

The specific population examined in this study is organizations doing business in Atlanta Georgia, regardless of revenue size, asset size, employee size, or industry sector. Firms whose headquarters were known to be outside the survey area were not approached. Included with the questionnaire was a letter of introduction explaining the purpose of the survey, information regarding informed consent, and details of a response incentive. During a four-week response period, 1168 surveys were delivered with 386 surveys returned (33%). Of the responses, seven were considered unusable, generating a net usable result of 379. The usable respondent surveys are considered adequate for this type of research.

The survey employs a systematic random sample approach and is delivered through the U.S. Postal Service. Each survey is addressed to the owner/general manager of the business. The questionnaire uses multiple response formats, gathering nominal, ordinal and interval data. In keeping with accepted statistical practice, an examination of the questionnaire's reliability and numerous validity measures were performed. Specifically, a questionnaire pre-test was conducted for face validity, and after 3 iterations, acceptable limits were obtained. The inter-item reliability alpha (Cronbach Alpha = .81) was also calculated and found to be inline with

acceptable consistency and accuracy thresholds for research of this type. The gathering of results concluded in October 2006.

The proposed technology services under investigation in this study is *Data Recovery Service* - will offer redundancy for an organization's data, Internet or external e-mail services. This service is provided by receiving the organizations data and e-mail then forwarding a copy to the customer organization. This buffering connectively permits: storage of a copy/archiving; filtering; virus detection and removal; external access in the event of a fault in the customer's servers.

Statistical Approach

Classification analysis and step-wise discriminant analysis techniques are used to examine variables associated with the predictability of performance category membership and the combinations of attributes most contributory for performance category development. Discriminant analysis is a technique of finding linear combinations of variables that best separate groups and was chosen for two reasons. First, the functions generated by the step-wise discriminant analysis have strong predictive applicability and the correct classification of export performers is provable. Using a step-wise method, variables are examined both forward and backward (other methods) one at a time to search for redundancy. The procedure stops when the largest partial F (one-way analysis of variance F statistic) among the variables is reached. The step-wise method searches for a distinct subset that maximizes the differences among the groups. This method generates a practical application for exporters seeking to identify which variables are the most influential for export success. Second, this method is common in the previous literature.

To account for upward bias in the estimating percentage of the classifications, a holdout method is used to ensure valid results. The holdout procedure randomly divides the sample. The holdout results should be relatively similar to the initial findings. They should at least be greater than the estimate for proportional chance. Proportional chance calculations follow the guidelines established by the Morrison (1969) Proportional Chance Criterion.

The dependent variables have been determined by classifying firms into one of four propensity categories. The categories are: 1) Will Not Adopt (WNA), 2) May Not Adopt (MNA), 3) May Adopt (MA), and 4). Will Adopt (WA). These categories are determined by the respondents own assessment of their intent to adopt data recovery services.

RESULTS

Respondent Profile

This section provides some general demographic and technological profile results from the survey. Percentage results provided are from those individuals responding to the specific questions, also referred to as the valid percentage. Every respondent did not answer every question, in every case. Respondent profile characteristics appear to reflect the business population in and Georgia are consistent with characteristics exhibited in previous similar studies (See Appendix).

In further examination of market viability, various business characteristics and their association with priority choices and expected adoption estimates are presented. Although these associations are quite useful, they are only a brief offering of some of the more complex analyses that can be employed, on these or additional variables not included. The examination of

characteristics with first priority choice compares each of the characteristics (business type, revenue, education level) with their percentage of selecting one of these services as their first choice (see Appendix).

Classification Analysis

The classification analysis correctly predicts 63.5 percent of the Georgian firms sampled into their respective propensity groups (see Table 2). The Morrison Proportional Chance Criterion (MPCC) is applied to determine if the predicted percentage is statistically greater than calculated proportional chance (Morrison, 1969). The result of the MPCC is 27.8 percent. Therefore, the classification analysis prediction of this study is 35.7 percent higher than proportional chance, supporting the predictability of propensity classification membership. Specifically, 63 percent of the *Will Adopt* firms, 60 percent of the *May Adopt* firms, 66 percent of the *May Not Adopt* firms, and 65 percent of the *Will Not Adopt* firms are classified correctly.

Using a randomly selected hold-out sample (179 respondents), the classification analysis correctly predicts 56.9 percent of the firms correctly into their respective performance groups (see Table 3). The MPCC is 28.7 percent, remaining well below the recalculated predicted results. Therefore, it is concluded that the classification functions for these sampled firms are useful for predicting export performance.

TABLE 2
CLASSIFICATION MATRIX

Actual Grouping	Predicted Grouping				Actual Total
	<i>Will Adopt</i>	<i>May Adopt</i>	<i>May Not Adopt</i>	<i>Will Not Adopt</i>	
Will Adopt	63% 20	8	3	1	16% 32
May Adopt	9	60% 31	8	4	26% 52
May Not Adopt	7	8	66% 50	11	38% 76
Will Not Adopt	1	3	10	65% 26	20% 40
Predicted Total	37	50	71	42	100% 200

Total Correct Classification = $((20+31+50+26)/200)(100) = 63.5\%$

Proportional Chance Criterion = $(.0256 + .0676 + .1444 + .0400)(100) = 27.8\%$

TABLE 3
CROSS VALIDATION OF CLASSIFICATION MATRIX
USING A HOLDOUT SAMPLE

Actual Grouping	Predicted Grouping				Actual Total
	<i>Will Adopt</i>	<i>May Adopt</i>	<i>May Not Adopt</i>	<i>Will Not Adopt</i>	
Will Adopt	56% 16	9	2	2	16% 29
May Adopt	8	56% 27	10	3	27% 48
May Not Adopt	6	14	57% 41	11	40% 72
Will Not Adopt	2	4	6	60% 18	17% 30
Predicted Total	32	54	59	34	100% 179

Total Correct Classification = $((16+27+41+18)/179)(100) = 56.9\%$

Proportional Chance Criterion = $(.0256 + .0729 + .1600 + .0289)(100) = 28.7\%$

Discriminant Coefficients

When examining the discriminant coefficients, more useful implications for the study are obtained. The canonical coefficients are determined by minimizing the Wilks' lambda value in

the discriminant function. Each determinant has a distinct coefficient strength. Table 4 presents the significant determinants that provide the greatest discriminating power. Focusing on the *Will Adopt* firms, six of the variables display a positive relationship with performance. In order of coefficient strength, they are: (1) Expectations for Security of Markets from Innovation; (2) Expectations for Efficiency from Innovation; (3) Commitment to New Business Processes; (4) Commitment to a Formal Innovation Adoption Policy; (5) Aspirations for Efficiency, and finally; with a negative strength; (6) level of capital investment..

Respondents clearly indicate that efficiency from adopting and commitment to the procedural evaluation of innovative options are very important. Additionally, no particular differential advantage was shown to have a positive impact on service innovation adoption however a firm's capital investment size had a negative impact on adoption propensity.

TABLE 4
SIGNIFICANT FUNCTION COEFFICIENTS WITH MEANS

<i>Determinant</i>	Will Adopt		May Adopt		May Not Adopt		Will Not Adopt	
	coef	mean	coef	mean	coef	mean	coef	mean
Capital Investment [DA_CI]	-2.438	2.96	-2.972	3.09	-3.381	3.56	-3.599	3.67
Aspirations for Efficiency [A-E]	.694	3.66	.489	3.46	.366	3.19	.290	3.07
Expectations for Efficiency from Innovation [E_EI]	3.991	3.79	3.999	3.73	2.408	3.38	1.827	3.01
Expectations for Security of Markets from Innovation [E_SMI]	7.006	3.97	6.622	3.72	5.014	3.44	4.191	3.06
Commitment to New Business Processes [C_NBP]	2.120	3.83	1.556	3.54	1.298	3.52	.9673	3.18
Commitment to a Formal Innovation Adoption Policy [C_FIP]	1.406	3.58	1.118	3.49	1.012	3.44	2.717	3.16
constant								
		-1.382		-2.785		-4.011		-5.236

Wilks' lambda = .257 sig. = .000

The coefficients used in the function are all significant

CONCLUSION

This study's intent is to: (1) examine various frequencies and descriptives of technology service adoption; (2) confirm that the innovation adoption of technology services can be classified; and (3) identify managerial determinants that influence the adoption of technological services. A further intent is to employ a proven non-linear approach for classifying firms with their propensity to adopt or not to adopt a new technological service innovation.

Managerial implications are for firms seeking to potentially adopt new technology innovations. Findings identify particular determinants within the control of management that play a vital role in the adoption propensity of firms. Most notably, managements' focus on efficiencies of the organization along with a commitment for making the organization better are the key determinants of adopting firms. Furthermore, it is also apparent that differential firm

advantages, such as size or investment patterns, along with managers' aspirations for growth or profit play an insignificant role in technological service adoption rates.

The study is useful because it: (1) provides a framework for analyzing the adoption patterns of firms, (2) presents insight into the behavior of American firms and their propensity to adopt innovations; (3) identifies variables associated with service technology adoption determinants, (4) provides managers with a benchmark to assess their adoption posture. Further research in this area should include the use of longitudinal studies, cross-cultural studies and the development of more complex operational variables.

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APPENDIX 1

Demographic

Gender	<u>percentage</u>
Male	65.2
Female	34.8
Age	<u>years</u>
Minimum	23
Maximum	73
Average	48
Highest Level of Completed Education	<u>percentage</u>
high school diploma	33.3
vocational or college diploma	23.6
university degree	34.8
additional university degree	5.6
none of the above	2.7
Years in Business	<u>years</u>
Minimum	1
Maximum	100
Average	21
Primary Business Type	<u>percentage</u>
Retail	34.5
Wholesale	2.7
Manufacturing	9.7
Professional Services	25.1
Personal Services	13.3
Other	14.7
Number of Employees	<u>count</u>
Minimum	1
Maximum	841
Average	23

Revenues for FY2005	<u>percentage</u>
less than \$25,000	2.7
\$25,000 - \$49,999	7.4
\$50,000 - \$99,999	12.1
\$100,000 - \$249,999	19.8
\$250,000 - \$499,999	14.2
\$500,000 - \$999,999	16.5
\$1,000,000 - \$5,000,000	20.9
greater than \$5,000,000	6.5

Technological Orientation

Importance of Computer to the Firm	<u>percentage</u>
not important	15.6
somewhat important	13.3
important	45.4
extremely important	25.7

Do you expect to upgrade current company computers/servers within the next 12 months?	<u>percentage</u>
No	33.9
Yes	66.1

Is there a person in your organization whose sole responsibility is to manage and protect company data?	<u>percentage</u>
No	64.2
Yes	35.8.

Is there a person in your organization whose sole responsibility is to maintain and update company computers/servers?	<u>percentage</u>
No	54.3
Yes	45.7

If you were going to adopt one of this service, what type of provider would you look for first?	<u>percentage</u>
IT Solutions firm (i.e.,IBM)	29.2
National Solution Contractor (i.e.,Accenture)	6.5
Regional Telecommunications firm (i.e., Atlanta T1)	20.1
National Telecommunications firm (i.e., ATT)	26.8
Internet Facilitator firm (i.e., Microsoft)	14.5
Science Institution (i.e., Univ of Georgia)	2.9