The Initiation, Adoption, and Implementation of Telecommunications Technologies in U.S. Organizations

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ABSTRACT: Despite the increasing pervasiveness of telecommunications technologies, very few studies have holistically attempted to examine their use in organizational contexts. This study approaches the use of these technologies from an innovation perspective. Literature on innovation is synthesized into a testable model and the results of a senior IS executive survey of 154 organizations is reported. Factors that enable initiation, adoption, and implementation of a set of 15 distinct telecommunications technologies are examined. Two factors in particular, environmental uncertainty and decentralization of decision making, show significant relationships with the usage of these technologies. The results provide useful insights into the usage of individual technologies and the contextual factors that enable diffusion of this important set of technologies in U.S. organizations.

KEY WORDS AND PHRASES: adoption of telecommunications, implementation of telecommunications, organizational innovation, telecommunications technologies.

OVER THE PAST DECADE, WE HAVE WITNESSED A PROLIFERATION of telecommunications technologies. These technologies are becoming increasingly intertwined with conventional data-processing activities, giving rise to a new class of applications [29, 67]. As

Journal of Management Information Systems / Summer 1993, Vol. 10, No. 1, pp. 141–163

more and more applications and sophisticated features are added to the telecommunications infrastructure, its importance to the business community is becoming increasingly evident [9].

Keen [37] describes the changing impact of telecommunications on businesses in terms of three distinct eras. In the first era, which he calls the operations era, businesses were primarily concerned with operational details and costs associated with the plain old telephone system (POTS). Around the time of AT&T divestiture, many firms began to consolidate communications and data processing in an attempt to reduce costs, incompatibility, and complexity involved with the proliferation of telecommunications technologies. This he called the internal utility era. The transition to the third stage is now beginning to be realized, where top management recognizes that telecommunications is more than operations and control, but an essential part of the business infrastructure, which, if properly managed, can increase organizational effectiveness. The arguments presented by Keen make a strong case for the inexorable importance of telecommunications to IS and its increasing impact on business.

While few will deny the importance of telecommunications technologies, it is indeed surprising that the treatment of these technologies by information systems (IS) researchers has been, at best, sporadic. Further, there is very little empirical research on topics related to telecommunications in the IS literature. The studies that are published either deal with telecommunications and its impact in a very general sense [29, 41, 70], or in terms of competitive implications and interorganizational links [2, 3, 7, 9, 34, 62], or in terms of specific cases and applications [11, 24, 47, 51, 52]. While these perspectives make important contributions to understanding various facets of telecommunications, there is a need to study more holistically the set of technologies being adopted by organizations as well as the factors facilitating their adoption and implementation. Doing so not only gives us a descriptive perspective on the utilization of various technologies, but also helps us understand the contexts important for their success. This study adopts such a perspective. Specifically, the objective of our study is to examine a set of telecommunications technologies and the factors that facilitate their diffusion in organizational contexts.

This paper reports the results of a study involving 154 organizations. A research model is proposed and tested. The theory behind the model is discussed in the following section. Much of this is based on innovation literature. The model and variables are then discussed, followed by sections describing methodology and results.

Background

THERE HAS BEEN A GREAT DEAL OF EMPIRICAL WORK in the field of innovation which spans many disciplines and focuses on both organizational and individual levels. Innovation has been described as an idea, a product, a technology or a program that is new to the adopting unit [10, 28, 59, 77]. The process of organizational innovation is often viewed as a stage-based process, with typically three stages: initiation, adoption, and implementation [56, 60, 72]. *Initiation* includes pressure to change, and gathering and evaluation of information, culminating in the *adoption* stage. Adoption involves the decision to commit resources to the innovation. The final stage, *implementation*, includes development and installation activities to ensure that the expected benefits of the innovation are realized [72]. This study views telecommunications technologies as innovations [62] and examines the factors facilitating their initiation, adoption, and implementation.

Kwon and Zmud [42] discuss the innovation literature in terms of five sets of factors: individual, task-related, innovation-related, structural, and environmental. Individual factors such as job tenure, role involvement, and education are related to individual adoption behaviors and consequently are not directly relevant to this study. Task factors (i.e., task autonomy and task variety) deal with innovativeness in a specific task context rather than with a general organizational context; as such they are not considered in this research. Specific factors related to an innovation such as its compatibility, complexity, and relative advantage are associated with the relationship between a specific innovation and its context. Since we are dealing with multiple technologies collectively, these factors also are not considered. The two sets of contextual factors investigated in this study are structural and environmental; both provide the context for organizational adoption.

Much research has investigated the effects of formal structural factors on innovation, especially on initiation and adoption behaviors. The major variables in this category have been organizational size, specialization, centralization, and formalization. The results on organizational size have been ambivalent and arguments have been made for larger sizes (i.e., greater slack, economies of scale) and smaller sizes (greater flexibility) to foster innovation adoption [74]. Specialization in terms of technical specialist diversity has been found to be generally positively associated with both initiation and adoption behaviors [39, 49]. Centralization, the concentration of decision-making activity, has often been found to have a negative relationship with initiation and adoption behaviors [28, 49]; some positive relationships have been found with implementation. Decreased autonomy and a bounded perspective are often given as reasons for the negative association with this variable. Similarly, formalization, defined as clear work and well-documented procedures, has been found to be negatively associated with initiation and adoption [28, 78] and positively associated with implementation [49].

Numerous studies that border on both innovation and strategic management literature have focused on environmental variables and their impact on organizational innovation. Some environmental contingencies discussed have been general, such as environmental uncertainty and heterogeneity [16, 56]. Generally it has been found that uncertainty and heterogeneity stimulates innovation through an organization's effort to survive and grow. Other studies have been more aligned with the task environment, such as competitive intensity [39, 75] and resource concentration [1]. Positive associations have been found between adoption and both these variables.

Clearly, the amount of empirical innovation research has been substantial and diverse. It has also been limited both conceptually and methodologically. Tornatzky and Klein [73] have pointed out problems with innovation research. These include:

- The need to focus on both adoption and implementation as the dependent variable (possibly including a scale that measures degree of implementation).
- The need to avoid generalizations from the individual adoption process to the organizational innovation process. In other words, the organizational unit undergoing innovation should be the locus of data gathering: alternatively, as suggested by Hage [26], the most involved member of the adopting unit would be the most informed respondent.
- The need to use replicatable and reliable measures.

This study attempts to alleviate these concerns.

The Research Model

BASED ON THE INNOVATION LITERATURE DISCUSSED ABOVE, the research model for this study is designed to consist of three sets of variables: environmental factors, structural (organizational) factors, and information systems (IS) factors. These variables are hypothesized to influence the initiation, adoption, and implementation of telecommunications technologies. The model is illustrated in figure 1, and discussed in the following sections.

Environmental Factors

Innovation literature consistently recognizes that environmental contingencies such as environmental uncertainty and heterogeneity facilitate innovation [16, 56, 64]. The case for the use of information technologies and environmental contingencies has been discussed by Pfeffer and Leblebici [55]:

> Under conditions of relatively undifferentiated environments that are quite stable, organizations should be able to cope with the information processing requirements without elaborate information technology. It is when the organization faces a complex and rapidly changing environment that information technology is both necessary and justified.

Duncan [18] demonstrated that environmental uncertainty is captured by two major components: complexity and rate of change. Miller and Friesen [48] conceptualize uncertainty into the components of heterogeneity, dynamism, and hostility. In this study, the broader construct of environmental uncertainty will be used. The arguments proposed by Pfeffer and Leblebici [55] in the context of general information technology and Keen [37] in the context of telecommunications, support the following hypotheses.

H1a: Environmental uncertainty will be positively related to the extent of initiation of telecommunications technologies.
H1b: Environmental uncertainty will be positively related to the extent of adoption of telecommunications technologies.
H1c: Environmental uncertainty will be positively related to the extent of implementation of telecommunications technologies.

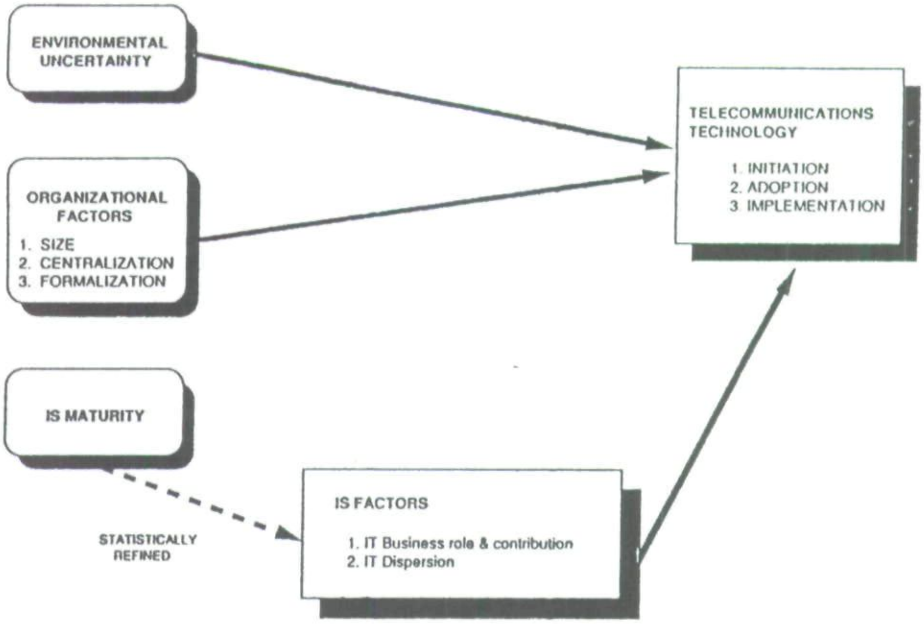

Figure 1. Research Model

Structural (Organizational) Factors

Four organizational variables have consistently been discussed in an innovation context: size, centralization, formalization, and specialization.

Organizational size has been the subject of scrutiny in many studies. While most studies posit that larger firms are more innovative due to their ability to absorb more risk [15, 49, 75], some studies indicate that the increased flexibility of smaller firms facilitates innovativeness [23]. The case made here is that we would expect larger organizations to have the resources and infrastructure to facilitate the initiation, adoption, and implementation of telecommunication technologies.

H2a: Organizational size will be positively related to the extent of initiation.
H2b: Organizational size will be positively related to the extent of adoption.
H2c: Organizational size will be positively related to the extent of implementation.

Centralization refers to the degree of decision-making concentration. Decreased autonomy in decision making has generally led to negative relationships between centralization and initiation [28, 49] and adoption [56]. Some positive relationships, however, have been reported between centralization and implementation [39, 78]. From an organizational design perspective, it has been asserted that greater implementation of communications technologies reduces uncertainty at higher managerial levels, thereby facilitating the entralization of decision making [6, 14]. From these viewpoints, the following hypotheses are proposed.

H3a: Centralization will be negatively associated with the extent of initiation.
H3b: Centralization will be negatively associated with the extent of adoption.
H3c: Centralization will be positively associated with the extent of implementation.

Formalization refers to the degree of reliance an organization places on formal rules and procedures. Most innovation research reports negative associations with initiation [28, 77, 78] and positive associations with adoption [39, 49, 56, 78] and implementation [78]. It is proposed that for telecommunication technologies, highly formal organizations would tend to have difficulty in the creative process of initialization, while the formal procedures would facilitate adoption and implementation.

H4a: Formalization will be negatively associated with the extent of initialization.
H4b: Formalization will be positively associated with the extent of adoption.
H4c: Formalization will be positively associated with the extent of implementation.

Specialization refers to the diversity of specialists within the organization. Technical expertise and experience are used to explain the positive effects of specialization [42]. With telecommunications technologies, this expertise generally resides in the IS/telecommunications department. Therefore, a broader view of specialization is applied in this study, as reflected in the maturity of the IS organization.

IS Factors

Information system maturity is an elusive concept discussed in various contexts in the IS literature [4, 53, 63]. Many IS characteristics have also been discussed in the literature that describe factors associated with "better or more mature" IS departments. These characteristics are: (1) top management's knowledge of information technology [33, 44], (2) top management's involvement in IS planning [45, 46, 57], (3) the extent of infusion and diffusion of IT[1] [69] and (4) IS performance criteria based on organizational goals rather than cost [4]. The increasing convergence of telecommunications and computing suggests that mature IS groups would tend to be proactive in evaluating and implementing telecommunications technologies. The hypotheses proposed involve a positive relationship between IS maturity and initiation, adoption, and implementation of telecommunication technologies.

H5a: IS maturity will be positively related to the extent of initiation.
H5a: IS maturity will be positively related to the extent of adoption.
H5a: IS maturity will be positively related to the extent of implementation.

Table 1 lists relevant references for each construct considered. It should be noted that most of the empirical studies cited in the table look at relationships between constructs and do not explicitly deal with causality.

Table 1 References for Model Constructs

Construct	References
Environmental uncertainty	Cyert and March [12]; DiMaggio and Powell [16]; Duncan [18]; Hawley [30]; Lawrence and Lorsch [43]; Miller and Friesen [48]; Mohr [50]; Pierce and Delbecq [56]; Thompson [71]; Schroeder and Benbasat [64]; Van De Ven and Ferry [76].
Organizational size	Blau and McKinley [5]; Dewar and Dutton [15]; Ettlie [19]; Ettlie et al. [20]; Globerman [23]; Moch and Morse [49]; Pierce and Delbecq [56]; Rothwell [61]; Utterback [75].
Centralization	Hage and Aiken [27; 28]; Kimberly and Evanisko [39]; Moch and Morse [49]; Pfeffer and Leblebici [55]; Pierce and Delbecq [56]; Thompson [72]; Zaltman et al. [77]; Zmud [78].
Formalization	Hage and Aiken [27]; Kimberly and Evanisko [39]; Moch and Morse [49]; Pierce and Delbecq [56]; Robey and Zeller [58]; Thompson [71]; Zaltman [77]; Zmud [78].
IS maturity	Benbasat et al. [4]; Gibson and Nolan [22]; Nolan [53]; Sabherwal [63].

Methodology

THE HYPOTHESES DESCRIBED ABOVE ARE DEFINED AT THE ORGANIZATIONAL LEVEL of analysis. It therefore becomes important to have a senior informed respondent within the organizational unit. The following sections describe data collection, instrument development, validation, and the sample of organizations surveyed.

Data Collection

Data were collected using an instrument that was carefully developed and pilot tested. Pilot testing was done by administering the questionnaire to senior IS executives and academicians with experience in this area; feedback was solicited concerning the items and their relevance to the constructs. The study sample respondents were randomly selected from the Standard & Poor's 1991 Corporate guide [66] and The *Information Week* 500 (compiled by IW [32]). The names of listed vice presidents/directors of IS were collected.

Construct Operationalizations

Fifteen telecommunications technologies were selected for this study[2] (see Table 3 on p. 154). An initial set of technologies was identified based on a review of telecommunications texts and articles. This initial list was then reviewed by three senior executives in charge of telecommunications operations at their companies and three academicians knowledgeable about technologies. Based on discussions with these six "experts," the set of technologies was iteratively refined. The objective of these discussions was to identify a fairly comprehensive set of technologies that could be communicated concisely and considered collectively for purposes of analysis.

Questionnaire respondents were asked to indicate *initiation* by responding to the question of whether a formal evaluation had been conducted to evaluate each technology. This was done for all fifteen technologies. Extent of initialization was measured by a simple count of the number of technologies formally assessed for adoption. This procedure is similar to one followed by Zmud [78, 79] in measuring initialization of software practices. *Adoption* was measured for each technology by asking the respondent if a decision had been made by the organization to adopt the technology. Extent of adoption was then measured based on a count of the number of technologies adopted. This measure is similar to those of Moch and Morse [49] and Ettlie [19] in the innovation literature. *Implementation* was measured on a seven-point Likert scale for each technology. This scale attempted to capture the extent to which each technology was implemented through the organization. Aggregation of scores over all technologies provided the extent of implementation score. Similar measures were used by Ettlie et al. [20] and Zmud [78].

Environmental uncertainty was measured using Miller and Friesen's [48] widely used multiple-item scales which capture the three components of uncertainty: heterogeneity, dynamism, and hostility.

Organizational size was measured using a self-reported sales figure. Given the resource-based arguments for the hypotheses related to size discussed earlier, it was determined to be a more appropriate measure of size than alternative measures (e.g., number of employees). Even though this measure is widely used in practice to capture size, we found that financial institutions had some difficulty responding to this item. Therefore, secondary data were used to capture current year net sales for financial firms. Net sales facilitates direct comparison between financial and nonfinancial institutions [65].

Centralization and formalization were measured using Hage and Aiken's [27] multiple item measures. IS maturity was captured using items developed by Sabherwal [63]. Despite the use of previously validated measures, all constructs were retested for reliability and validity.

Sample

Nine hundred and sixty questionnaires were mailed, of which 183 were returned unopened due to changed respondent address. This resulted in an effective mailing of 777 of which 165 responses were obtained. This reflects a response rate of 21.23

percent. However, 11 responses were incomplete and had to be discarded, leaving 154 responses for the data analysis.

Figure 2 illustrates the sample profile. Sixty-three percent of the sample is comprised of finance and manufacturing firms. The domination of these two industries is fairly representative of the distribution among larger firms [e.g., 17, 35, 40] which would suggest moderate nonresponse bias on this dimension. The sales profile indicates a domination of larger firms, with 86 percent of the sample firms having sales over $100 million. Also, the respondent sample indicates a high level of seniority: 64 percent of the respondents assume director, vice president, or higher-level positions. Such seniority puts them in the best position to respond to the constructs at the organizational level. It is interesting to note that, of the repondents at the director or vice president level, 34 percent had "telecommunications" in their title. In contrast, almost all the respondents at the managerial level had "telecommunications or communications" in their title. As the questionnaire was mailed to senior executives, this might indicate that some of them passed the instrument down to a telecommunications manager, who they might have felt would be in a better position to respond to the survey. In addition, over 80 percent of the organizations indicated a telecommunications function within the responsibility of the IS group, indicating the appropriateness of the sample.

Construct Reliability and Validity

Construct reliability and validity are frequently ignored aspects of MIS survey research [68]. In this study, steps were taken to ensure that valid and reliable measures were being used. First, items were adapted from previously validated instruments. Second, the reliability and validity of the measures were reassessed with the current sample. Third, method bias [68] was reduced by using different types of measures for the independent and dependent variables.

Cronbach's alpha was calculated to assess measurement reliability. It should be noted that while Cronbach's alpha can be artificially inflated through method bias and a larger number of items, it is widely used to evaluate internal consistency of a construct. In this study, an attempt was made to reduce method bias by dispersing the items for various constructs throughout the questionnaire. Several heuristics have been suggested regarding acceptable levels of standardized alphas. Nunnally [54] prescribes a value of 0.70 or higher to be acceptable. Table 2 describes the items used for measuring each construct and the corresponding alpha. All alphas were greater than the prescribed 0.70 level, thereby implying an adequate level of internal consistency.

One of the most powerful methods to test construct validity is factor analysis [38]. If all items in the independent variables are factor analyzed and load in accordance with the *a priori* theoretical expectations, then significant aspects of construct validity have been assessed (i.e., the ability of homogeneous items to converge together on a factor and away from other factors) [25, 54]. Principal component analysis was conducted using all the items listed in Table 2. Given the low multicollinearity, orthogonal rather than oblique rotations were performed to avoid ambiguities in interpretation [25]. From this analysis, a seven-factor solution emerged that accounted

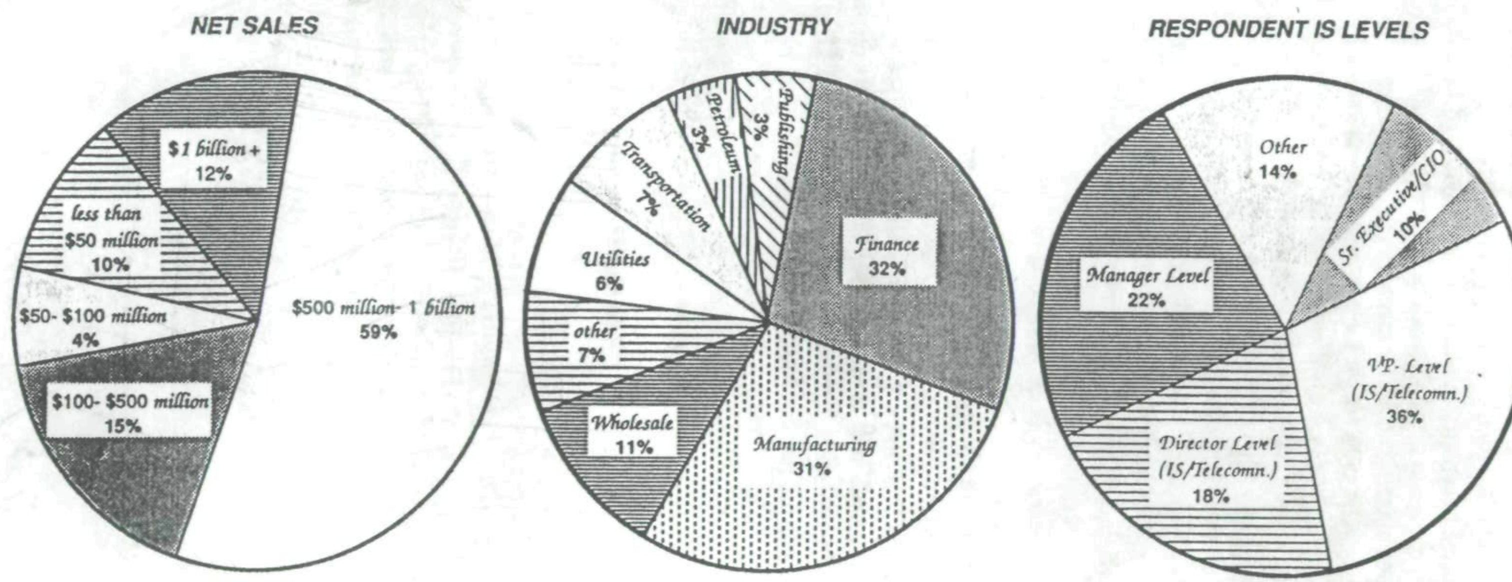

Figure 2. Respondent demographics

for 66 percent of the variance. For each item, the highest factor loading and the corresponding factor number (on which it loaded) are shown in the right column of Table 2. While there is no generally accepted standard on significance of factor loadings, given the large sample size, a general cutoff point of 0.40 was chosen [38, pp. 572]. However, most of the items chosen had factor loadings greater than 0.5.

Centralization and formalization loaded onto single factors in accordance with *a priori* expectations. Environmental uncertainty loaded onto three factors that were consistent with Miller and Friesen's [48] proposed dimensions of the construct: heterogeneity (factor 4), dynamism (factor 3), and hostility (factor 7). Therefore, the factor structure for uncertainty was consistent with the *a priori* theoretical expectations. However, two items measuring hostility had low loadings on all the factors and were consequently dropped from further analysis [8, 25]. Correlations computed between all the dimensions of uncertainty and all three correlations were significant at $p < 0.001$. Three factors justify the consolidation of survey items to measure environmental uncertainty: (1) consistency with theoretical dimensions, (2) high interdimension correlations, and (3) internal consistency [21].

IS maturity loaded on two distinct factors (factors 1 and 6). One item, possibly due to negative wording, negatively loaded onto factor 6 and was dropped from further analysis. Another item concerning distribution of IS personnel did not load significantly on any factor, and was also dropped from further analysis. Closer analysis of the itemsassociated with each factor reveals that factor 6 reflects the dispersion of IT through the company. Factor 1, however, depicts impact of IT on the business as reflected by the IT awareness of top management, integration of IS and corporate planning, and contribution of IS. While the proactive organizational role of IS and the dispersion of IT resources are perhaps both representative of IS maturity, there is limited theoretical support for such a proposition. Consequently, IS maturity was divided into two separate constructs based on the factor solution: IT business role and contribution, and IT dispersion. This refinement of the model is illustrated in figure 1. Hypotheses 5a, b, and c are therefore modified as follows:

> *H5.1: IT business role and contribution will be positively related to the extent of initiation (H5.1a), adoption (H5.1b), and implementation (H5.1c) of telecommunications technologies.*
>
> *H5.2: IT dispersion will be positively related to the extent of initiation (H5.2a), adoption (H5.2b), and implementation (H5.2c) of telecommunications technologies.*

Results

Telecommunications Technologies

To gain insight into utilization of telecommunications technologies in business organizations, descriptive statistics were computed for each technology. These statistics are presented alongside a listing of technologies in Table 3. The second column of the table represents the percentage of responding firms that had

Table 2 Construct Reliability and Validity Analysis

	Factor loading
Centralization Cronbach Alpha = 0.86	
To what extent is the responsibility to make the following decisions in your company centralized at the top levels of management?	
Capital budgeting	0.7134[2]
New product introduction	0.8982[2]
Entry into major new markets	0.8475[2]
Pricing of major product line	0.8733[2]
Hiring and firing of senior staff	0.6763[2]
Formalization Cronbach Alpha = 0.71	
Whatever situation arises,we have procedures to follow in dealing with it.	0.7887[5]
When rules and procedures exist here, they are usually in written form.	0.7168[5]
The employees here are constantly checked for rule violations.	0.7229[5]
There are strong penalties for violating procedures.	0.8050[5]
Environmental uncertainty Cronbach Alpha= 0.72	
At what rate do products/services become obsolete in this industry?	0.6853[3]
How predictable are the actions of competitors?	0.7357[3]
How different are your company's products/services in reference to:	
Customer's buying habits	0.8369[4]
Nature of competition	0.8450[4]
Market dynamism and uncertainty	0.8443[4]
How severe a threat does each of the following industry aspects pose to your company?	
Price competition	0.7826[7]
Product quality/novelty competition	0.5149[7]
Dwindling markets for products	0.1720[4]
Scarce supply of materials	0.1908[4]
How predictable are customer demands and tastes?	0.7576[3]
At what rate does the technology change in this industry?	0.6960[3]
Our company must frequently change its marketing practices to keep pace with the market and competitors.	0.5079[3]

undertaken a formal evaluation of the technology. The third column indicates the percentage of firms that had committed resources to adoption of the technology. The final two columns report the mean and standard deviation for implementation as measured on a seven-point scale, ranging from "no implementation" to "extensive implementation."

Table 3 is divided into three broad categories of technologies. Category 1 includes technologies that have been formally evaluated by most firms (> 90 percent), have consequently been adopted (> 80 percent), and have also been extensively implemented (> 5.0). This category includes relatively mature technologies such as voice/data PBXs and FAX.

Category 2 includes technologies that have been formally evaluated by most firms (> 90 percent), adopted by most firms (> 80 percent), and have been moderately implemented (3–4). These include voice systems, LAN, WAN, E-mail, network management software, commercial database access, and interorganizational links.

Table 2 *Continued*

	Factor loading
IS Maturity Cronbach Alpha = 0.79	
How many different functions in your company are supported by information technology?	0.7423[6]
To what extent are mainframe terminals, minicomputers, word processors, process control devices, micros, etc., installed throughout your company?	0.7069[6]
To what extent are information systems personnel distributed throughout your company?	0.1771[1]
Information systems performance evaluation in your company is based on minimizing cost.	−0.2910[6]
Information systems performance evaluation in your company is based on contribution to corporate objectives.	0.4821[1]
How informed are your information systems managers about your company's business plans?	0.7777[1]
How informed is your firm's top management about information technology?	0.6982[1]
What impact has information technology had on your company?	0.4862[1]
How formalized is information systems planning in your company?	0.7854[1]
To what extent does information systems planning take your company's business plans into consideration?	0.8395[1]
How involved is top management in information systems planning?	0.8141[1]

Note: Factor loading superscript = factor number.

Category 3 includes technologies that have been formally evaluated by fewer firms (> 40 percent), but relatively fewer have chosen to adopt it, and have not been extensively implemented among adopters (i.e., < 3). These include expensive, novel, or substitutable technologies like ISDN, videoconferencing, videotext, VANs, owned communications lines, and intelligent/mobile phones.

Hypotheses Testing

To test the research hypotheses, multiple regression analysis was applied to investigate the relationships between each of the dependent variables and the six independent variables. Appropriate assumption tests for this technique (i.e., normality, variance equality, linearity) were performed. No assumption was violated.

To test for multicollinearity, the intercorrelation matrix for all six independent variables was examined. This is described in Table 4. As can be seen from the matrix, only 2 of the 15 correlations are significant at the $p < 0.01$ level, thereby implying very little multicollinearity. The highest correlation is between IT contribution and IT dispersion. Since items relating to these two factors were originally conceived as a part of the IS maturity construct, this correlation is not surprising. It implies that firms with IT dispersed through the organization also tend to recognize the integral role of IT to the business. While it is difficult to infer the causality of the relationship, the high correlation (0.44) should be kept in mind when one is interpreting the results.

Table 3 Telecommunications Technology Assimilation

Technology	Percentage evaluated	Percentage adopted	Implementation score (7-point scale)	
			Mean	SD
Category 1				
FAX	99.4	99.4	5.8	1.3
Voice/data PBX	93.5	85.7	5.1	2.5
Category 2				
Access to commercial databases	90.3	85.7	3.1	1.9
Electronic mail	96.1	87.7	4.4	2.4
Interorganizational links	91.6	88.3	3.5	2.1
Local area networks (LANs)	97.4	92.9	4.8	1.9
Network management software	91.6	84.4	4.0	2.3
Voice-oriented systems (e.g.,voice mail)	95.5	85.7	4.4	2.4
Wide area networks (WANs)	89.0	77.3	4.3	2.8
Category 3				
Intelligent/mobile phones	76.6	69.5	2.4	2.0
Owned communication lines	74.7	60.4	2.9	2.8
ISDN	66.2	31.8	0.9	1.7
Value added network (carrier)	85.1	68.2	2.7	2.4
Video conferencing	72.7	37.0	1.2	2.0
Video text	40.9	22.1	0.7	1.6

The second significant correlation is between environmental uncertainty and IT contribution. While the magnitude of the correlation is relatively small (0.21), it does suggest that firms in uncertain environments tend to emphasize the business role of IT. This could be due to the informational/competitive demands put on the organization by an uncertain environment and the need to address them proactively through information technology.

Three regressions were computed with initiation, adoption, and implementation as the dependent variables. The results are described in Table 5. The first column lists the set of independent variables used in each regression. Each of the three regressions is significant at $p < 0.01$.

Hypotheses 1a-c are strongly supported at $p < 0.01$ level of significance. Greater environmental uncertainty makes it necessary for organizations to evaluate more technologies as well as to adopt and implement them, in order to cope with greater information processing and flow requirements associated with such environments.

Hypotheses 2a-c are not supported. Size does not significantly influence initiation, adoption, or implementation of telecommunications technologies. These results are somewhat surprising, given the presumed argument that larger firms would have the resources for adoption of new technologies. Apparently both larger and relatively

Table 4 Construct Correlation Matrix

	1 Size	2 Centralization	3 Formalization	4 IT contribution	5 IT dispersion	6 Environmental uncertainty
1	1.0					
2	–0.1607	1.0				
3	0.0615	–0.0531	1.0			
4	–0.1362	0.0241	0.1713	1.0		
5	0.1158	0.0286	0.1494	0.4421*	1.0	
6	–0.1023	–0.1537	0.0021	0.2135*	0.1296	1.0

* $p < 0.01$.

smaller organizations are involved (or not involved) in evaluation, adoption, and implementation of these technologies.

Hypothesis 3a proposes a negative relationship between centralization of decision making and initiation of technologies. This is supported at the $p < 0.05$ level. The results support the claim that more technologies will be evaluated in environments where decision-making authority is decentralized. Such environments are less autocratic and encourage innovative behavior. Hypothesis 3b proposes a negative relationship between centralization and extent of adoption. This too is supported at the $p < 0.05$ level. In other words, organizations where major decision making can occur at multiple points may tend to acquire different technologies at those multiple points, leading to greater adoption. H3c proposes a positive relationship between centralization and extent of implementation. Arguably, centralization will provide the structure required to facilitate implementation. Study results indicate significant influence in the opposite direction: decentralized organizations tend to foster greater implementation. While surprising, this result might be an artifact of the nature of the technologies being discussed. Telecommunications technologies play an integral role in moving information within and across organizations. Decentralized organizations might require greater information transfer and therefore broader implementation of these technologies. Unfortunately, the use of a unidimensional measure of implementation does not provide insight into the breadth and depth of implementation.

Surprisingly, none of the hypotheses involving formalization (H4a-c) is supported. Greater formalization in organizations does not lead to differences in the use of telecommunications technologies.

Probably more surprising is that none of the hypotheses involving IT contribution (H5.1a-c) is supported. Organizations that recognize the business impact of IT do not initiate, adopt, or implement telecommunications technologies any differently than

Table 5 Regression Analysis

	Initiation	Adoption	Implementation
Uncertainty			
Beta	0.2381	0.2469	0.2225
T	2.7640	2.8400	2.6340
Sig *T*	0.0065	0.0053	0.0095
Size			
Beta	0.1079	0.1145	0.0783
T	1.2500	1.3140	0.9250
Sig *T*	0.2136	0.1911	0.3567
Centralization			
Beta	−0.2076	−0.1946	−0.1801
T	−2.4640	−2.2880	−2.1800
Sig *T*	0.0151	0.0238	0.0311
Formalization			
Beta	0.0588	0.0207	0.0160
T	−0.7010	0.2440	0.1950
Sig *T*	0.4848	0.8073	0.8458
IT contribution			
Beta	0.0370	−0.0185	0.0999
T	0.3840	−0.1910	1.0560
Sig *T*	0.7017	0.8491	0.2927
IT dispersion			
Beta	0.0665	0.0000	0.1764
T	0.7180	0.0000	1.9410
Sig *T*	0.4741	0.9999	0.0544
F statistic	3.5168	3.0548	4.5093
Significance	0.0030	0.0079	0.0004

organizations that do not. This might suggest that such organizations make a more careful evaluation of technologies relevant to business needs and initiate, adopt, and implement accordingly. The emphasis of the dependent measures on diversity of technologies might overlook this aspect. To ensure that multicollinearity between IT contribution and both dispersion and uncertainty is not distorting the regression analyses, correlations were computed between IT contribution and all three dependent variables. Only the correlation between IT contribution and implementation was significant at $p < 0.05$. Therefore, it can be concluded that while contribution does not relate to the extent of initiation and adoption, there may be a positive relationship with the extent of implementation. Firms that recognize the business impact of IT do not necessarily evaluate or adopt more technologies but do implement technologies adopted to a greater extent.

IT dispersion is not significantly related to initiation or adoption (H5.2a, b) but is positively related to implementation (H5.2c). In other words, firms that have technology dispersed throughout the organization will tend to implement telecommunications technologies to a greater extent, possibly to coordinate and integrate dispersed hardware and data.

To summarize, organizations that face greater uncertainty in the environment and that decentralize decision making would tend to evaluate and adopt more telecommunications technologies. Firms that face greater uncertainty, greater decentralization of decision making, and greater dispersion of IT tend to implement the adopted technologies to a greater extent.

Discussion and Implications

ON A DESCRIPTIVE NOTE, THE STUDY PROVIDES INSIGHT into the utilization of telecommunications technologies by U.S. businesses. While academic articles consistently use "telecommunications" to represent a broad spectrum of technologies, the results of this study indicate the voice/data PBXs and FAX are the only two technologies that have been widely adopted and implemented. Others, such as local area networks, electronic mail, commercial database access, and interorganizational links are widely adopted and are "moderately" implemented, which might imply that they are in the process of being diffused through organizations. The much discussed value added networks, videoconferencing, and ISDN are just beginning to be evaluated and adopted.

Little doubt exists on the part of the respondent sample that uncertainty is a prime motivator for acquiring and processing information. Telecommunications technologies are the principal facilitators to support information acquisition and distribution. Environmental uncertainty (EU) significantly influenced the complete innovation cycle (i.e., initiation, adoption, and implementation). In the context of this survey as noted in Table 2, EU was measured from several dimensions. Reports from this respondent group make it clear that corporations in dynamic and competitive environments are constantly scanning and implementing new technologies. Firms in similar environments that fail to do the same may quickly fall to a noncompetitive status. Since a positive correlation (+0.21) is apparent between EU and IT contribution, firms that face uncertainty view IT as a potential solution to their business challenges. Thus, uncertainty yields both communication and information processing capabilities to remain competitive. On the negative side, those companies that overreact to competitive challenges may make unreliable assessments of the effects of IT. Technologies may pass through the organization so quickly that little stability exists for learning and ultimately reaping promised benefits. Popular IS literature is replete with concerns about failures to provide promised productivity returns for IT investments. Corporations, given these insights, should be cautious about either overreacting or underreacting to these technologies. For unstable industries or markets, this research suggests that scanning and adoption behaviors must be continual to remain competitive.

The demographic profile of these respondents deserves recognition. Among these corporations, in great part, are the most sophisticated IT users in the country. Their reaction to uncertainty is strongly predicated on telecommunications technologies.

That is, uncertainty yields dependence on more and more technology to remain competitive and rapidly respond to business problems.

Implicit in this discussion is the issue of competitive advantage. While this topic is not the focus of this study, little doubt exists that as more technologies are acquired, other firms must compete with these technologies. Ultimately, a surge toward competitive advantage among the most sophisticated corporations to maintain or surpass telecommunications technology parity may ensue. Benefits in this setting may be ephemeral.

This research identifies significant differences between firms with centralized (i.e., the extent to which decisions are concentrated at the top levels of management) and those with more diffused decision levels. Since more telecommunications technologies (TT) tend to be evaluated in decentralized cultures as well as more adopted, one might conclude that distributed decision-making styles are most beneficial. More autocratic, less innovative IS professionals may tend toward reactive, inward-directed activity. An inverse relationship, however, is expected for implementation: centralization facilitates implementation. The results suggest otherwise. While danger exists that disjointed acquisition efforts underwrite duplication and obstacles to integration, those closest to customers, suppliers, and other constituencies instrumental to profitability may offer the most accurate view of what may be needed technologically to remain competitive. Implementation can be and often is assisted when expertise and standards exist to assure a smooth transition from one TT to another. If this is the case, the results suggest that decentralized organizations might tend to have decentralized expertise to implement TT. An alternative plausible explanation is that in organizations where major decision making is decentralized, TT plays a vital coordination role that is essential for the organization to evolve as an entity.

In many ways, formalization (extensive rules and procedures) results are surprising. Many corporations attempt to establish consistent approaches to technology acquisition. This varies from developing internal methodologies (i.e., formal system request approaches) to purchasing documentation systems that force corporate members to follow rigid guidance. Study results underscore that this construct is immaterial to the TT innovation process. Two rationales may be appropriate: the technologies exhibit characteristics that force multi-unit acquisition and thus are amenable to either formal or informal settings as long as coordination occurs, or the locus of control for these technologies depends on technical expertise, regardless of the level of administrative control exercised. In any case, attempts by companies to influence TT acquisition and implementation activities via administrative fiat may not yield anticipated results.

Organization size is found not to influence TT initiation, adoption, or implementation. While surprising from a superficial perspective, institutions regardless of size may be able to take advantage of new technologies if the expertise and motivation exist. Many if not most of the technologies listed can be acquired at incremental costs that match the capitalization of particular companies. Local area networks and interorganizational links can be developed with the capabilities and characteristics needed for the tasks required; overbuilding due to extensive minimum capabilities is not mandated. In addition, a threshold may exist so that virtually all firms that have reached a certain capitalization level can afford whatever TT is needed. Large corporations should be wary of attempting to leverage their competitiveness with TT without adding differentiated value to products or services.

Information technology distributed throughout the firm certainly provides inherent justification to search for and acquire TT for linkage and information flow. In addition, distribution more assures a concomitant allocation of system expertise to implement new technologies. Firms moving from centralized to decentralized technology platforms may have greater difficulty when attempting to implement integrative technologies such as TT than those that seemingly encountered problems with "islands of information" noted in earlier IS literature. While these "islands" created unseen roadblocks to coordinated corporate effort, they appear to facilitate the information linkages to be implemented.

Conclusion

THE CAUSAL RELATIONSHIP BETWEEN THE ORGANIZATION AND TECHNOLOGY has been extensively discussed. The two prevalent schools of thought are those that advocate a technological imperative versus those that propose an organizational imperative, depending on the causal agent [13]. While causality has not been directly addressed in this study, the innovation perspective taken, implicitly implies an organizational imperative. In other words, the fundamental question addressed is: what contextual factors facilitate the utilization of telecommunications technologies (i.e., new technologies or innovations for the organization). It should be recognized however, that researchers, [e.g., 31, 36] are now beginning to look at the technological imperative for telecommunications technologies, that is, the impact of these technologies on organizational factors. The objective of these two streams of research is to better manage both deliberate and emergent change due to technology.

In this study, our goal was to gain an understanding of the factors that facilitate the extent of initiation, adoption, and implementation of telecommunication technologies. It should be noted that these contextual factors essentially represent general conditions under which it would be easier and beneficial for organizations to initiate, adopt, and implement these technologies. For instance, it is proposed that organizations in highly uncertain environments, with mature IS departments, will gain more from greater implementation. Actual behaviors of organizations, however, may be influenced by the idiosyncrasies of their decision-making processes and their specific cost–benefit equations regarding specific technologies. Therefore, the model presented is not fully explanatory for any particular technology or organization. On the other hand, it represents certain contexts and associates them with collective implementation of a set of technologies.

Several relationships have been identified that provide insights to both practitioners and academics. Many of the findings portend future avenues for productive research. From this early effort, replicated measures have been revalidated. Measurement reliability and validity are more assured for future investigation. As one of the first empirical and methodologically consistent studies to investigate telecommunication technologies holistically from an organizational perspective, the study can be a basis for in-depth investigation of specific factors. Anchored in theory, this study synthesizes much of the innovation theory research currently published. This concern for theoretical consistency should provide a common reference point for other theoretical work that can build a cumulative body of knowledge.

Several characteristics of this study offer opportunities to researchers interested in this area. For instance, the measurement of implementation in this study was unidimensional. More refined measures for breadth and depth of the implementation constructs can yield greater insights into business assimilation. For example, what manifestations of implementation exist across organizations? Do implementation strategies emphasize in-depth implementation at single sites before migrating to other locations or are single installations more often completed throughout the firm? Measurement of initiation and adoption of telecommunication technologies involved dichotomous responses (i.e., yes or no). A more refined approach to recognized variation in these alternatives would enable additional understanding of significant variations and their influence on implementation. Relationships between centralization and implementation in a telecommunications context also remain ill-defined. While only so much measurement can occur with a respondent sample of this type, considering the questionnaire collection method, researchers can consider these findings to develop additional instruments for more in-depth investigation. Finally, the question of "success" was not addressed here. What constitutes success in terms of adoption and implementation? Do high technology adoption rates and relatively low levels of implementation equate to low adoption and high implementation levels? Obviously, the unique characteristics of telecommunications technologies and their increasingly important influence on corporate survival encourage further investigation. The results of this initial empirical investigation have exposed several aspects of the telecommunications innovation cycle that stimulate additional research in this increasingly vital area within the information system field.

NOTES

The authors contributed equally to the execution of this project.

1. It should be noted that the term information technology (IT) is being increasingly used to represent the myriad convergent technologies that implement the basic functions of storage, processing, and communication of information.

2. These technologies represent a myriad of hardware, software, and platforms, each of which is an individual initiative on the part of the organization.

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