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# Web Technology Diffusion - Initial Adoption, Assimilation and Network Prominence

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# Initial Adoption, Assimilation and Network Prominence

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## ABSTRACT

This study conceptualizes a staged model of web technology diffusion across enterprises and considers initial adoption, assimilation and the emergence of network prominence as progressive phases that build upon earlier outcomes. Based on the resource-based view of the firm and organization learning theories, we suggest that success at each innovation stage is based on overcoming the knowledge barriers that arise in the utilization of complex technologies. Factors related to the financial resource base, the prominence of the IT function, expertise in the IT domain and a visionary growth orientation are proposed to be important. We test three models corresponding to different phases of the technology diffusion process based on secondary data for a large sample of enterprises. Dedicated financial resources allocated to IT and Internet-related initiatives are found to be associated with reduced time to initial adoption. The level of IT budget as well as prominent leadership of IT function are found to be associated with website sophistication. Companies in the information technology industry and information-intensive services industry had more sophisticated websites but were not associated with higher network prominence. As expected, early initial adoption of technology led to higher network prominence judged through the number of web links from other sites. Our results suggest the need to take a multi-dimensional and staged perspective of complex technology diffusion.

## INTRODUCTION

Research on technology diffusion in organizations has primarily focused on the varying intentions to adopt for different adopting units. Recent research has extended these traditional approaches by suggesting that adoption of complex technologies requires a significant amount of organizational learning and that organizations that are unable to surmount the knowledge barriers posed by the new technology may not be able to assimilate the technology even in the presence of an intention to adopt (Fichman & Kemerer, 1997). Further, competitive pressures within an industry can hasten the decision to adopt (Chwelos, Benbasat, & Dexter, 2001). In this research, we propose that in the case of technology implementations that are embedded in and structured by inter-firm networks, there may be a further stage beyond assimilation – the network prominence that occurs when website deployments are recognized by other firms and gain a reputation which makes them feasible for appropriation through inter-website links.

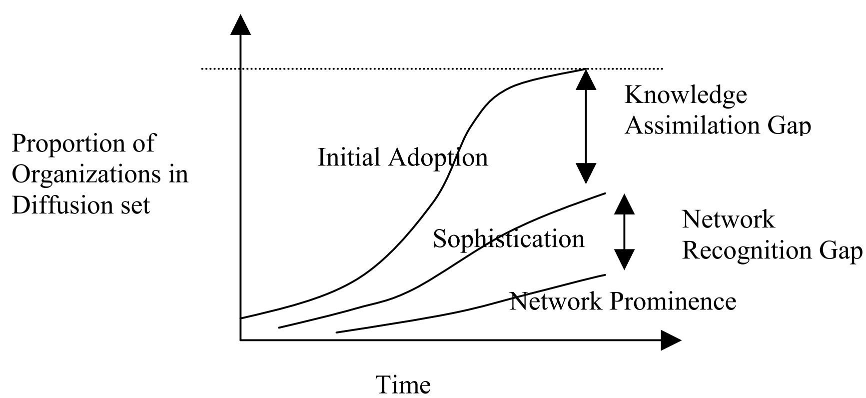


**Figure 1. Knowledge Assimilation Gap & Network Recognition Gap**

Figure 1 illustrates our conceptualization of how complex technology diffusion may be constrained by knowledge assimilation gaps that arise because of organizational learning limitations and the network recognition gap which arises because of the delays in awareness and appropriation that need to occur across enterprise boundaries.

On an enterprise level it is clear that web technology adoption is not a one-shot deal – it is an ongoing process of adapting and appropriating technology. Rollyson (1999) presents a taxonomy of adoption phases based on differentiating features observed in practice (Table 1):

| | **Dawn of Consciousness** | **Experimentation** | **Early Specialization** | **Integration** | **Transformation** | **Breakaway** |
|---|---|---|---|---|---|---|
| **Approach** | Early adopters, people tinker | Tinkerers begin to accumulate knowledge | Knowledge begins to be recognized within enterprise | People in enterprise serious about web as a communication vehicle | Website seen as primary tool to develop/maintain customer relationship | Website no longer distinguishable from core enterprise systems |
| **Web-Interaction** | Brochure-ware | Gadgets like frames and dynamic pages | Some interactive features; self-service applications | Real-time dynamic site that permits some individualized experience | Offers customers ability to manage key aspects of relationship | Communities of interest, processes enabled by rich knowledge sharing |

**Table 1. Stages in Technology Assimilation**

Taxonomies similar to this, based on an evolutionary view of website technology, have been proposed in practitioner outlets (cf. Coleman, 1998). This view suggests that we need to open up the technology adoption black-box to see how stages in the whole process may be differentiated and specific success factors be isolated.

## THEORETICAL DEVELOPMENT

Our theoretical development is informed by three main perspectives. First, we view firm performance as strongly influenced by the capabilities of the firm that are derived from its distinctive resource base. Second, the adoption of complex technologies such as web technology requires organizational learning capabilities that allow for an organization to assimilate the technology. Third, we view web technologies as a connectivity infrastructure and the successful assimilation of such technologies is reflected in the manner in which they are structured and become a basis for relational linkages among organizations.

**Organizational Capabilities**

The notion of organizational capabilities has been developed within the resource-based view of the firm (e.g., Barney, 1991; Peteraf, 1993; Teece, Pisano, & Shuen, 1997). In this view, a bundle of assets, rather than the particular product market combination chosen for its deployment, lies at the heart of a firm's competitive position (Dierickx & Cool, 1989). In the resource-based view, resources are distributed heterogeneously across firms, and these productive resources cannot be transferred from firm to firm without cost (i.e., resources are "sticky"). Competitive advantage is derived in large part from internal, firm-specific resources and capabilities. How a firm's resources and capabilities are acquired, developed, and deployed by its managers defines the firm's relative competitive position, and the sustainability of that position depends on the ease with which competitors can imitate or replicate the firm's acquisition, development, and deployment of those resources and capabilities.

A capability is defined as a firm's capacity to deploy its assets, tangible or intangible, to perform a task or activity to improve performance (Amit & Schoemaker, 1993; Grant, 1991; Teece et al., 1997). Important characteristics of capabilities are that they are knowledge-based, firm-specific, and socially complex, and they generally cannot be simply acquired in factor markets but are developed within the firm. Capabilities are often associated with large firms, which in turn, are often better able to provide slack resources and dedicated staff to test out new innovations (Damanpour, 1992; Rogers, 1995). The adoption and assimilation of web technology requires enterprise capabilities in understanding the technologies, creating a vision for their deployment and adapting the technologies for the specific conditions of the enterprise. This capability is derived in large measure from an enterprise's experience with other IT and the skills of its IT function (Chwelos, Benbasat, & Dexter, 2001; Fichman & Kemerer, 1997; Premkumar & Ramamurthy, 1995). Complex technologies such as the web present opportunities for adoption that may not be clearly apparent and the specific mode of deployment may be very context-specific. A strong resource base in information technologies may permit the synthesis of competencies or linkage of diverse competencies related to the web.

**Knowledge Barriers to Technology Assimilation**

Traditional models of diffusion (Rogers, 1995) assume that adopting entities have the same opportunity to adopt and the diffusion patterns that result are a reflection of a varying intention to adopt of the individual entities. Economic diffusion models look at cost-benefit factors while behavioral-usage models consider factors related to the technology such as complexity, ease of use, compatibility, observability and triability. Attewell (1992) proposed an organizational learning perspective of technology diffusion that suggests that the adoption of new technologies involves new knowledge creation. While learning is central to adoption of any technology and has been emphasized in the classical diffusion models (Rogers, 1995), Attewell (1992) distinguished between learning about the presence and the benefits of an innovation (accounted for in typical contagion models) and the learning required to understand and use the technology.

Classical studies on diffusion have emphasized the communication links that are required for contagion effects to drive technology adoption (Ravichandran, 2001). On the other hand, obtaining the knowledge required to assimilate and deploy technologies is likely to play an important role in patterning the diffusion of complex technologies (Attewell, 1992). Complex technologies when first introduced impose a high knowledge burden on would-be adopters (Fichman & Kemerer, 1997). These technologies may have an abstract and demanding scientific base, tend not to operate always as expected, are difficult to try out and cannot be easily unbundled (Tornatzky & Fleischer, 1990). In such contexts, technical knowledge tends to be sticky (Von Hippel, 1994) and may have to be "discovered de-novo" within a user organization (Attewell, 1992). Rosenberg (1982) argued that the knowledge required to use a technology involves breaking open and examining what transpires "inside the black box" of technological phenomena. Such knowledge is costly and difficult to diffuse because it deals with the specific and the particular, consists of innumerable small increments and may be tacit (Rosenberg, 1982). The extent to which an organization is able to overcome these knowledge barriers will influence when and how successful it will be in adopting and assimilating a technology.

### *The Assimilation Gap*

Fichman & Kemerer (1999) propose the assimilation gap that refers to the difference between the cumulative acquisition and employment patterns for new technology. The two factors of increasing returns to adoption and knowledge barriers impeding adoption, separately or in combination, may serve to predispose the technology to exhibit a pronounced gap. To successfully assimilate a complex technology, an organization must make the effort to get from the current bundle of knowledge to the needed bundle. This distance is likely to be smaller for organizations that have experience in using technologies related to the technology being adopted. The current related knowledge possessed by an organization also determines its absorptive capacity for new knowledge. Knowledge in the firm needs to be technical, diverse, and cross-functional (Cohen & Levinthal, 1990). Organizations that do not have the related experience may not even be able to recognize the value and importance of a new technology, let alone adopt it (Ravichandran, 2001). Thus, it is likely that experience in related information technologies will have an impact on technology assimilation by lowering the knowledge barriers a firm has to overcome in adopting a technology.

## Social Capital and Network Prominence

An emerging theme in strategy research has been the shift in focus from the theme of value appropriation to one of value creation (Ghoshal & Moran, 1996). While the transaction cost theory is rooted in assumptions of opportunism and resulting market failure, researchers have begun to emphasize the nature of organizations as social communities (Kogut & Zander, 1996). Nahapiet &

Ghoshal (1998) develop the role of social capital in facilitating the combination and exchange of intellectual capital and the creation of new intellectual capital. Social capital refers to the actual and potential resources embedded within, available through and derived from the network of relationships possessed by a social unit. Based on structuration principles, Gulati (1998) suggests that there exists an endogenous network dynamic between an embedded organizational action and the network structure that guides, but is also transformed by, that action. Ties between entities in a network tend to become more structured over time. These prior ties, both direct and indirect, create a social network in which most firms are embedded, and it becomes an important source of information for them about the reliability and capabilities of their current and potential partners. Such information helps firms to learn about new tie opportunities and also enhances their trust in current and potential partners.

On the web, one of the key measures of value is the number of other sites that link into a focal one. Website links represent a recognition of value across organizational boundaries. These links may be guided by existing organizational networks and social capital and also shape these over time. Websites with greater links-in suggest a more prominent network position. Just as relational ties between organizational members can be used to develop an informal network structure within an organization, ties in cyberspace may similarly bind organizations. As a result, the value of a website may be strongly affected by its linkages and thus its network position.

## CONCEPTUAL MODEL

Figure 2 shows the basic research model (constructs and proposed indicators) that is based on the prior theoretical development. The model is based on a multi-dimensional staged view of web technology assimilation. Early adoption of the technology is predicted by a set of organizational factors. These same organizational factors and early adoption are used to predict sophistication of web presence (a measure of assimilation stage). Finally, all the previous variables are used as predictors of network prominence, itself a measure of successful implementation of web technologies. The proposed organizational antecedents are based on the perspective that assimilation requires slack financial resources, an appreciation for the value and role of IT, expertise in related technology and a need and vision for sustained growth.

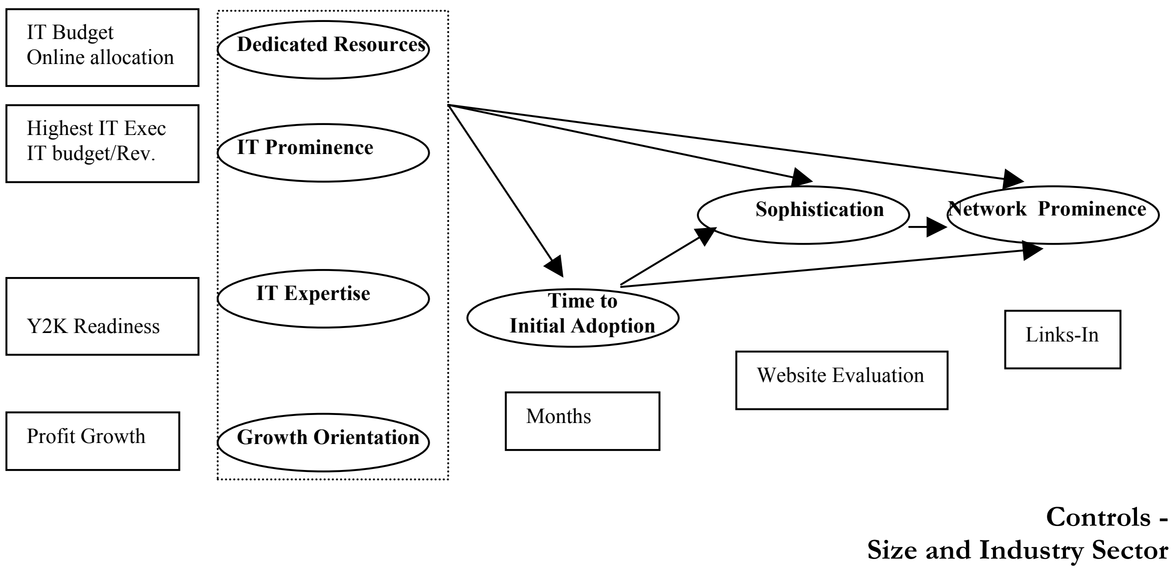


**Figure 2. Research Model**

### *Financial Resources Dedicated to IT*

The adoption of technology requires resources that consume untapped commitments or alternate opportunities that the firm could have pursued. The consumption of financial resources is frequently constrained by decision-maker perceptions of financial risk or personal goals on financial control (Gatgnon & Robertson, 1989). Researchers have found that the investment requirements and available financial resources are important considerations in strategic decisions about adoption of technology (Dowling & McGee, 1994; McGrath, Venkatraman & MacMillan, 1994). Given, that website technology requires considerable financial investments without certainty of returns – sophisticated websites may cost millions of dollars and require extensive operational expenses (Ghosh, 1998), we propose that:

*H1: The slack financial resources dedicated to information technology use within a firm will be positively associated with the adoption and assimilation of web technologies and the network prominence of its corporate website.*

### *IT Prominence*

Previous research suggests that predicting a firm's response to new technology necessitates an examination of the leadership and strategic direction of senior management (Zmud, 1984). A consistent finding in early research on system implementation is that management support is related to success. A firm that emphasizes IT as a key component of its corporate strategy is likely to have recognized the potential importance of the Internet and to have established a site. Kambil et al. (2000) found that management awareness of IT and its public discussion of success stories in the annual report predict the adoption of Web technology. Further, they found that management leadership strategy, the need to communicate and firm resources were weakly associated with specific characteristics of Web sites. Earlier research on technology adoption suggests that a proactive technological orientation facilitates adoption of new information technologies (Grover, 1993). The importance of a formal technology strategy (Gatignon & Robertson, 1989; Zahra, 1996) is also considered important. A technology strategy is a company's plan of action for acquiring, developing and exploiting technological resources. Since, the prominence of the IT function in an organization is expected to lead to a business strategy that emphasizes technology infrastructure and also articulates this in specific terms, we propose that:

*H2: The prominence of the IT function in the firm will be positively associated with the adoption and assimilation of web technologies and the network prominence of its corporate website.*

### *IT Expertise*

The knowledge barrier perspective suggests that firms will vary in their ability to address their learning requirements associated with an innovation. With respect to web technology the knowledge barriers could be technology-related, project-related or application-related (Nambisan & Wang, 1999). To address these barriers the firms may decide to create the new knowledge internally or acquire it from external sources. In either case, this will introduce delays in the adoption process. The acquisition of external knowledge not only requires financial resources to be expended in the acquisition, but also requires the ability to integrate this knowledge with existing firm knowledge and match it to organizational needs. Adaptable and integrated technical infrastructures are critical for enabling business enterprises to take advantage of e-business opportunities. However, the e-business solutions that provide competitive market advantage do not come in a box, and will most likely involve multiple technologies from multiple vendors. Integration of Web technology with the existing IT infrastructure is recognized as a costly and technically demanding endeavor (Kalakota & Robinson, 2001) and prior competencies are likely to be important for website development (Kowtha & Choon, 2001). Since web-technology related knowledge is likely to be related to its IT expertise, we propose that:

*H3: A firm's IT expertise will be positively associated with the adoption and assimilation of web technologies and the network prominence of its corporate website.*

### *Growth Orientation*

Enterprises tend to view the same web technology differently depending on the perceived benefits that they seek (Beatty, Shim & Jones, 2001). Some firms may be more likely to adopt innovations than others due to a market pioneering or growth orientation. Competitive pressures may cause such an orientation or it may be a function of an entrepreneurial organization that is willing to act proactively and respond quickly to market opportunities. IT investment decisions such as outsourcing have been associated with firms facing slower growth trajectories (Smith, Mitra & Narasimhan, 1998).Firms growing rapidly have been found to be highly willing to invest in radical innovation opportunities even at the cost of existing investments (Chandy & Tellis, 1998). Companies with higher rates of growth may be better prepared to deal with organizational change needed to deploy and leverage website presence, Hence we propose that:

*H4: A firm's growth orientation will be positively associated with the adoption and assimilation of web technologies and the network prominence of its corporate website.*

### *Controls: Size and Industry*

We have included controls for size and industry types in the model because industry type can lead to confounding effects because of industry-specific environmental conditions and size can also systematically influence organizational practices. For instance, smaller firms may lack the entrenched internal stakeholders such as salespeople opposing interactive website marketing. Firm size has been found to be significant in explaining adoption patterns (Rogers, 1995; DeLone, 1988) and a key Schumpeterian hypothesis is that small firms innovate more "intensively" than large firms do. Size has particularly been found to account for adoption of information technologies such as database technology (Grover & Teng, 1992). Companies in digital product or service industries (e.g., banking) may similarly be expected to be more proactive at adopting website technology given a more pressing business need and a more suitable delivery medium. Likewise, IT industry companies are expected to be more proactive in technology adoption as they could be expected to be more aware of technology developments, more skilled in using and customizing them to their specific conditions and also more likely to want to be seen on the cutting edge.

## RESEARCH METHOD AND CONSTRUCT OPERATIONALIZATION

This study is based on secondary data obtained from a number of different sources as well as a primary evaluation of corporate websites (Table 2). Financial measures and IT investment data for 1997 was obtained from Business Week and Information Week's annual review of the top 500 firms for use of IT. Data gathered from BW includes firm financial performance statistics and industry data. Data gathered from IW include the size of the IT budget, the budget allocation for Internet initiatives, the proportion of systems that were Y2K compliant and the highest-ranking IT executive. Data on website functionality was gathered in 1998 from Alexa, Media Metrix and website visits.

The one-year lag between financial performance and investment data is based on industry perceptions of the time it takes for such complex technology implementations to come to fruition. The time to adoption is computed as the number of months elapsed since December, 1985.

| Construct | Operationalized As | Data Sources |
|---|---|---|
| **Time to adoption** | Log of months elapsed upto IP domain registration (event) | Network Solutions WHOIS database |
| **Sophistication** | Five point scale<br>1. Informational – brochure-ware<br>2. Informational, but advanced technology such as site maps and fancy graphics<br>3. Interactive – games, discussion boards, downloads<br>4. Interactive – asks for customer information – customization, membership or cookies<br>5. Transactional – electronic commerce, shopping carts | Coded through site visits, August 1998 |
| **Network Prominence** | Links-in to site | Alexa |
| ***Independent Constructs*** | | |
| **Dedicated Resources** | | |
| IT Budget | 1997 IT Budget (log) | Information Week |
| Online Allocation | Proportion of IT budget allocated to Internet initiatives | Information Week |
| **IT Prominence** | | |
| Highest IT Executive | 1 – Manager<br>2 – Vice-President<br>3 – Senior Vice President<br>4 - CEO | Information Week |
| IT Budget Proportion | 1997 IT Budget/1997 Revenues | Information Week (IT data)<br>Business Week (Financial Data) |
| **IT Expertise** | | |
| Year 2000 readiness | % readiness for Y2K | Information Week |
| **Growth Orientation** | | |
| Profit Growth | Profits Growth (1997 over 1996) | Business Week |
| ***Controls*** | | |

| | | |
|---|---|---|
| **Size** | Log 1997 Revenues | Business Week |
| **Industry** | Information Intensive Services (eg. Financial services, insurance)<br>Information Technology | Business Week |

**Table 2. Construct Operationalization**

Our choice of the date of registration of IP domain as an indicator of initial adoption of website technology is based on the view that this point in time is a signal of the initial awareness of the potential of Internet technology and occurs at the same time as the organization starts its deployments of the basic infrastructure to support its website. Our contention is that websites are based on a complex set of technologies related to communication networks and routers, web and application servers, firewalls and security infrastructure as well as tools for web development, content management, load balancing etc. Therefore, alternate indicators such as the date of unveiling of website to public use may significantly lag the technology adoption.

Our operationalization of website sophistication is based on typologies that classify websites into generations based on a staged framework (cf. Kowtha & Choon, 2001; Huizingh, 2000). While the classification scheme is simple, it is well-suited to the early days of the Internet, where each higher level reflects the overcoming of a technical hurdle – dynamic web pages, transactional databases or personalization, for instance. A limitation of this simple scale is that it does not account for the case where an organization may not see some of these features as relevant to its business needs.

The data analysis is conducted in three staged models. The first model was modeled as a duration model (Cox Regression) with time to adoption as the dependent variable.

The proportional hazard model is the most general of the regression models because it is not based on any assumptions concerning the nature or shape of the underlying survival distribution. The model assumes that the underlying hazard *rate* (rather than survival time) is a function of the independent variables (covariates); no assumptions are made about the nature or shape of the hazard function. Thus, in a sense, Cox's regression model may be considered to be a nonparametric method. The model may be written as:

$h\{(t), (z_1, z_2, ..., z_m)\} = h_0(t)*\exp(b_1*z_1 + ... + b_m*z_m)$

where h(t,...) denotes the resultant hazard, given the values of the m covariates for the respective case (z1, z2, ..., zm) and the respective survival time (t). The term h0(t) is the baseline hazard - it is the hazard for the respective individual when all independent variable values are equal to zero.

The second model is an OLS regression model with website sophistication as the dependent variable and the third model is another OLS regression model with network prominence of the website as the dependent variable. These two models aim to explain the variation in sophistication and network prominence across websites, rather than the timing of the diffusion, unlike the first model.

## RESULTS

Table 3 presents the summary statistics and table 2 shows the correlation matrix for the data. For Model 1 (hazard model), four organizations had not deployed a website at the time of the data collection (January, 1998). The observations for these cases are right censored.

We had to eliminate the control for firm size (log of revenues) in the models because it was very highly correlated with the IT budget (Pearson correlation - 0.778**). Survival analysis programs protect against problems associated with multicollinearity but the analysis is best served by a set of covariates that are not highly related (Tabachnik & Fidell, 2001). For the regression models, multicollinearity was assessed by looking at the correlation statistics. The variance inflation factors in both models 2 and 3 were found to be within tolerance limits for all independent variables and variance inflation factors were close to 1, indicating no major issues with multicollinearity.

Another key check was to test for the proportionality of hazards assumption prior to Cox regression. It was found that none of the covariates interacts significantly with time and therefore the assumptions are met.

We also checked for the presence of significant outliers. Due to the skewed distribution of the 'IT budget' variable a logarithmic transformation was used to correct for positive skewness. Also, the 'links-in' dependent variable that is an indicator of network prominence was found to exhibit a similar skewed distribution. Additionally, we expect network effects to occur and lead to exponential growth in the 'links-in' with an increase in the level of the dependent variable. Hence, it was considered prudent to similarly transform the links-in variable.

Finally, due to limitations of collecting data from multiple sources, we could get data on all indicators for each case. This reduces the number of observations in each model to much below the total of 256 cases overall. We did conduct missing value analysis (not reported here) that suggest that the remaining cases would not significantly alter the model results.

| | N | Minimum | Maximum | Mean | Std. Deviation |
|---|---|---|---|---|---|
| Time to Adoption (Months) | 256 | 1.00 | 145.00 | 98.29 | 33.22 |
| Sophistication | 250 | 1.00 | 5.00 | 2.72 | 1.65 |
| Links In (Log) | 246 | .69 | 13.02 | 5.75 | 2.25 |
| IT Budget (Log) | 232 | 15.15 | 22.20 | 18.40 | 1.30 |
| Internet Budget Allocation | 216 | .00 | .90 | 0.06 | 0.09 |
| Highest IT Executive | 255 | 1.00 | 4.00 | 2.12 | 0.66 |
| IT Budget Prominence | 227 | .0019 | .1830 | 0.02 | 0.02 |
| Y2K Readiness | 219 | .04 | .99 | 0.51 | 0.26 |
| Profit Growth | 231 | -3.00 | 6.75 | 0.24 | 0.97 |
| Information Technology Industry | 256 | .00 | 1.00 | 0.07 | 0.25 |
| Information –Intensive Services Industry | 256 | .00 | 1.00 | 0.22 | 0.42 |

**Table 3. Summary Statistics**

| | (a) | (b) | (c) | (d) | (e) | (f) | (g) | (h) | (i) | (j) | (k) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| a. Time to Adoption | 1.000 | | | | | | | | | | |
| b. Sophistication | -.143 | 1.000 | | | | | | | | | |
| c. Links In | -.542 | .329 | 1.000 | | | | | | | | |
| d. IT Budget | -.382 | .412 | .546 | 1.000 | | | | | | | |
| e. BudgetAllocation | -.280 | .099 | .288 | .089 | 1.000 | | | | | | |
| f. Highest IT Exec. | .010 | .352 | .193 | .318 | .077 | 1.000 | | | | | |
| g. IT Budget Prom. | -.237 | .163 | .261 | .411 | .148 | .198 | 1.000 | | | | |
| h. Y2K Readiness | .023 | -.259 | -.021 | -.183 | .098 | -.078 | -.064 | 1.000 | | | |
| i. Profit Growth | .022 | .005 | -.058 | -.106 | .048 | -.058 | -.026 | -.104 | 1.000 | | |
| j. IT Industry | -.359 | .181 | .246 | .034 | .385 | .046 | .051 | .010 | -.042 | 1.000 | |
| k. Info Services | .138 | .314 | .034 | .202 | -.068 | .317 | .183 | -.083 | -.035 | -.143 | 1.000 |

**Table 4. Correlation Matrix**

### ***Model Estimation Results***

Table 5 provides the results of our model estimation while figure 3 illustrates the adoption pattern estimated in the first model.

The first model examines factors that impact the time to initial adoption of Internet technology. The event variable was coded as 1 for adoption and 0 for non-adoption (survival). The positive coefficients can be interpreted as increasing the hazard rate or reducing the survival time, thus increasing the likelihood of technology adoption. It is seen that the IT budget and the specific allocation to Internet-related initiatives is significantly associated with faster initial adoption. There is no significant increase in adoption with greater IT expertise. However, companies in the information technology industry are likely to adopt the technology earlier.

The second model examines factors that impact the sophistication of corporate websites. This again show that the level of the IT budget is significantly associated with website sophistication. In addition we find that there are mixed effects of the prominence of the IT function in the organization. While having IT executives in more prominent roles in the organization is associated with more sophisticated sites, prominence in terms of devoting greater proportion of the revenue to IT is negatively associated with website sophistication. Surprisingly, the extent of readiness of enterprises systems for the year 2000 was found to be negatively associated with sophistication. As expected, both IT industry companies as well as those in information intensive service industries had more sophisticated websites.

The third model examines the factors that impact the network prominence of corporate websites. Companies with higher IT budgets were found to have more linked sites. As expected, a greater delay in adopting Internet technologies was associated with a lower level of links to the site and thus less network prominence. Surprisingly the prominence of the IT function in terms of the IT budget was found to be negatively associated with network prominence.

| Variables | (1) Time to Initial Adoption [Hazard Model – Cox Regression] | (2) Sophistication [Linear Regression] | (3) Network Prominence [Linear Regression] |
|---|---|---|---|
| Constant | | -7.154*** (2.281) | -4.099 (2.783) |
| Time to Initial Adoption | | 0.005 (0.004) | -0.027*** (0.005) |
| Sophistication | | | 0.131 (0.098) |
| IT Budget | 0.454*** (0.087) | 0.491*** (0.119) | 0.635*** (0.148) |
| IT Budget Allocation for Internet Initiatives | 4.096*** (1.439) | 0.417 (1.899) | -0.810 (2.243) |
| Highest IT Executive | -0.133 (0.150) | 0.367* (0.198) | 0.162 (0.238) |
| IT Budget Prominence | 3.560 (4.113) | -14.706** (6.368) | -13.754* (7.656) |
| Y2K Readiness | 0.132 (0.307) | -0.850* (0.434) | 0.582 (0.520) |
| Profit Growth | 0.097 (0.081) | 0.009 (0.135) | 0.078 (0.163) |
| Information Technology Industry | 0.761** (0.380) | 1.698*** (0.491) | -0.579 (0.602) |
| Information –Intensive Services Industry | -0.361 (0.241) | 0.909*** (0.309) | 0.060 (0.376) |
| N | 161 (4 cases censored) | 154 | 153 |
| | | | |
| Overall Model | -2 log Likelihood 1279.77 chi-square 45.695*** | $R^2$ 0.32 Adjusted $R^2$ 0.27 F- Statistic 7.438*** | $R^2$ 0.39 Adjusted $R^2$ 0.35 F- Statistic 9.182*** |

**Table 5. Model Estimation**

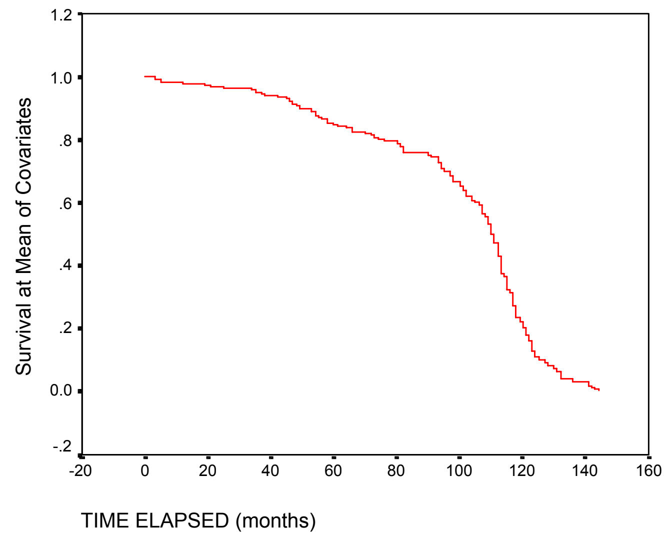


**Figure 3. Adoption Pattern**

## DISCUSSION

This study provides new insights to managers striving to develop an understanding of the organizational characteristics that contribute positively to the successful assimilation of website technology and other innovations. Our results show confirm that there are benefits to viewing the adoption of technology as a staged process that unfolds over time. Specifically, a major contribution of this study is the development of three inter-related measures of technology adoption. Our results also indicate that the factors that influence the assimilation of complex technologies vary over time. Further, as illustrated in Figure 1, there is a lag between the initial adoption and the assimilation of the technology. We find that while most enterprises had adopted the technology by the end of the time horizon (except for 4 censored cases), this was not reflected in the overall level of sophistication (2.72 average on a 5 point scale).

Some of the empirical results are contrary to stated hypotheses and need further elucidation. For both model 2 (sophistication of website) and model 3 (network prominence), IT budget prominence was negatively linked to the dependent variables. Similarly, Y2K readiness either was negatively linked or not significantly linked to the dependent variables. This unexpected result may be due to the amount of effort and attention that many organizations had focused in order to get their systems to be Y2K ready. A large number of enterprises during the period of interest either spent significant resources to make their systems Y2K compatible or migrated at great expense their systems to an ERP system (Kalakota & Robinson, 2001). If so, this focus on updating legacy systems may have been detrimental to firms that otherwise would have been innovators on the Web. It is also interesting to note that being in an IT or an information intensive industry is a strong predictor of early adoption of web technologies and even of advanced web site functionality. However, prowess in getting to the Web early did not pay off for these firms: these factors did not link to network prominence.

This study contributes to the literature on technology innovation by going beyond the traditional emphasis on perceived technology characteristics. We provide empirical support to the organizational learning framework developed by Attewell (1992) and elaborated by Fichman and Kemerer (1997) in an empirical study of the diffusion of complex Information technologies. Our findings extend previous results by measuring technology diffusion in multiple and complementary ways. Most organization level-studies have favored either a time to adoption perspective (e.g., Gurbaxani, 1990) or a stage of adoption perspective (e.g., Cooper & Zmud, 1990). We use both measures and contribute a network position dependent variable that integrates network prominence as a key aspect of technology diffusion.

The study does not suffer from common method bias, something that plagues many diffusion of innovation studies when the dependent variables and the independent variables are collected from the same stakeholder or data source. In this study, we used a variety of empirical sources to measure the independent variables. We also relied on observer coding to assess the state of the organization's website. Together, the use of independent data sources strengthens our confidence in the results.

This study has confirmed the role played by firm resources and knowledge that allow it to overcome the knowledge barriers that these technologies pose. While general financial strength may be important to pursue strategic initiatives, our results suggest that focused investments are even more vital. Thus we find that the budget devoted to IT and more specifically, to Internet initiatives is important to spur the initial adoption. We find that the prominence of the IT function in terms of budgetary spending may not help the assimilation process. Rather, having high-ranking executives as champions of the IT function may help spur more innovation. The results also illustrate the first-mover importance that enterprises obtain through quickly adopting and assimilating technology. The web-sites that have the largest number of links-in are those that have been around the longest.

This research is limited by its reliance on cross-sectional data collection and analysis. A cross-sectional research design, while providing comparison across a large sample, does not provide an in-depth understanding of the diffusion process as it unfolds in a specific organization. Further, this study has relied primarily on secondary archival data for understanding the conditions driving technology adoption and assimilation. Some of the measures may best be considered as proxies for more direct measures of these factors. For instance, IT spending is considered as a proxy for IT-related knowledge and expertise, which is notoriously difficult to measure directly. Future research may benefit from considering other measures such as perceptual evaluations of IT expertise. In addition, this study has mainly examined organizational factors that drive complex technology adoption. A promising direction to extend this research is to look at the role of supply side institutions and embeddedness in inter-organizational networks that facilitate or constrain the adoption process.

In conclusion, this study has presented a staged model of web technology adoption that takes a multidimensional view of initial adoption, assimilation, and network prominence outcomes. We tested the model using a sample of large firms from a diverse set of industries. We found that after controlling for the effect of industry, technology prominence and financial resource factors are key predictors of early adoption of the web as well as later network prominence.

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