

# The Effect of Environmental Factors on the Adoption and Diffusion of Telework

Cynthia Ruppel  
University of Toledo, USA

Geoffry S. Howard  
Kent State University, USA

*Telework ("telecommuting") has been predicted to dramatically alter the place-dependence of information-based work. Instead, the implemented incidence of employees being permitted to work at home remains quite low. This is puzzling, given the potential benefits of telework, including reduced commuting time, positive environmental impacts, decreased absenteeism, enhanced employee retention, and an expanded employee recruiting area. This study explores the relationship between environmental variables and the adoption and diffusion of telework among computer specialists in an effort to understand telework's slow growth. A national survey of information systems managers was conducted, with the result that the environmental factors of market competitiveness, competitor use of telework, industry globalization, and legislative mandates were found to be significantly related to adoption of telework. Competitor use of telework and external corporate communication significantly related to diffusion of telework. These results are useful in guiding managers who wish to stimulate telework practices, and to researchers exploring telework in greater depth.*

*Telework*, the electronic displacement of workers from their primary work location, offers potential benefits to employers and employees alike. Employer benefits may include increased telecommuter productivity, enhanced morale, decreased absenteeism, and improved employee retention and recruiting. (Seaman, 1997) Benefits to employees might include less stressful and less costly commutes, increased schedule flexibility, and proximity to family and community. (U.S. Department of Transportation, 1993; Scholtz, 1998). Because these potential benefits appear to constitute a win-win for both employers and employees, rapid growth in telework has frequently been predicted. (Toeffler, 1980) Surprisingly, though, the growth of telework has fallen far short

of expectations. (Christensen, 1990; Hughson & Goodman, 1986; Olson, 1987; Korzeniowski, 1997) Innovation theory provides two separate perspectives that constitute a useful starting point for probing why this may be so.

First, theory suggests that innovation proceeds in stages in most organizations, wherein the organization first becomes aware of the innovation, next recognizes that the innovation may be appropriate to meet its needs, adopts it for use, and finally diffuses it throughout the organization. These initiation, adoption, and diffusion stages have aided researchers significantly in understanding the mechanisms of innovation, (i.e. Zmud, 1982), and are applied in the present study.

A second perspective from innovation theory suggests

three groups of factors that may relate to the adoption and diffusion of innovations within organizations: those related to the *external environment* of the organization, those factors related to both the *structure and culture* of the organization, and those factors which facilitate the *compatibility* between the innovation and the organization. This study chooses to develop a special depth of understanding of the first of these three groups, *external environmental factors*, as they may relate to both the adoption and diffusion of telework in organizations.

For this study of environmental factors, computer programmers and systems analysts were chosen as subjects. This was because the information manipulation inherent in their work lends itself to remote electronic implementations, and because information system professionals could be expected to be comfortable with the technologies that support telework. (Ishii, 1995; Olson, 1989) Telecommuting is also particularly germane to the information systems profession because it offers at least a partial solution to the present acute technical labor shortage. (Ouellette, 1998). The reasoning was that if any significant correlates of telework existed in *any* occupational group, they would be most apparent among programmers and analysts.

A national mail survey was undertaken to determine which external environmental factors related significantly to adoption and diffusion of telework. In addition to the correlation data, considerable descriptive telework usage data were also obtained. The findings will be valuable to steer future telework research, and will serve to guide managers who wish to stimulate telework in their organizations.

## Relevant Research Literature

Environmental variables appear frequently in studies of innovation. (Van de Ven & Chu, 1989; Grover & Goslar, 1993; Kimberly & Evanisko, 1981; Tannenbaum & Dupree-Bruno, 1994) Van de Ven and Chu suggest that these environmental variables can conveniently be categorized into four groups: those related to the economic environment, to the technological environment, to the demographic environment and to the legal environment. While this classification includes both internal and external environmental factors, only the external factors will be considered in this study. Another characterization of environmental variables that is ubiquitous in the literature is perceived environmental uncertainty, which captures aspects of all four of the categories above. (Van de Ven & Chu, 1989) Several specific variables that are implementations of the environmental uncertainty theme appear in the present study.

The relevance of the above characterizations of environmental variables is upheld by many innovation studies have included external environmental variables in connection with innovation. For example, Grover and Goslar (1993) studied environmental uncertainty relative to the use of innovative telecommunications technologies. Hoffer and Alexander (1992) studied environmental factors related to the diffusion

of database machines. The importance of environmental variables in relation to the adoption and implementation of technical innovations in hospitals was studied by Meyer and Goes (1988). Similarly, Kimberly and Evanisko's (1981) study of innovations in hospitals also included environmental variables. Zmud (1983) investigated the relationship between the environmental variable external information channels and the adoption of "Modern Software Practices."

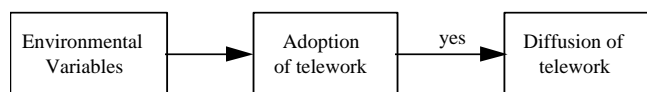
The importance of the study of the external environment to the adoption and diffusion of innovations is further emphasized by Marcus and Weber (1989). They suggest that innovations may be externally-induced and that these "external jolts" are often needed to stimulate innovation. They also suggest that externally-induced innovations require specific approaches to facilitate the successful adoption, and particularly the implementation, of the innovation. Therefore, it is important to determine the extent (if any) to which telework is an externally induced innovation so that the proper techniques can be developed and employed to maximize odds of successful diffusion.

Using the innovation *telework*, this study is designed to determine specifically which external environmental factors may have an impact on the adoption and the diffusion of this specific innovation. To identify specific environmental factors that may be relevant to the adoption and diffusion of telework, the telework literature was studied in light of the currently used innovation variables that are related to the environment.

Studying this literature yielded a list of specific environmental variables which had been used in other studies and which were consistent with the above typologies and characterizations. (Korzeniowski, 1995, for example). The telework literature was then searched for references that gauged the relative importance of these factors in the adoption and use of telework. This search ultimately resulted in identification of the following external environmental factors for empirical study: 1) perceived competitiveness of the marketplace, 2) implementation of telework by perceived competitors, 3) perceived globalization of the marketplace, 4) communication with external consultants, 5) the existence of regulatory legislation, 6) perceived shortage of external labor supply, and 7) perceived sensitivity to concerns with the ecological environment. (Adam, 1997).

Variables 1, 2, and 3 relate directly to the environmental uncertainty theme prevalent in the existing body of innovation research. Turning to the Van de Ven and Chu categories, the economic environment is a component of variables 1, 2, and 6, the technological environment of variables 2 and 3, the demographic environment of variable 7, and the legal environment of variable 5. The environmental factors selected for inclusion in the present study are consistent with existing innovation research as well as with the accepted typologies and characterizations of external environmental variables. A model of the "innovation system" thus characterized appears in Figure 1.

Each of these variables selected for study was



**Figure 1: Organizational Environmental System**

operationalized by measuring the perception of the top IS manager in each organization surveyed. It is frequently these *perceptions* which are acted upon in the decision to adopt and diffuse an innovation at the organizational level. Each of these environmental variables, and their relationship to the adoption and diffusion of telework, are discussed in detail below.

## Hypotheses Related to External Environmental Variables

### Competitiveness of the Marketplace

The competitiveness of an organization's marketplace has been studied previously in the innovation literature. For example, Grover (1993) found weak support for the relationship between the adoption of customer-based interorganizational systems and a high degree of competition among firms. Premkumar and Ramamurthy (1995) found that competitive pressures influence the adoption of EDI. Kimberly and Evanisko (1981), in their study of innovations in hospitals, found that the adoption of innovations was influenced by the presence of competition in the area in which the hospital was located.

Telework has many potential benefits which, if properly implemented, allow an organization to improve its competitive position. (Dangelmaier, 1998) For example, one of the most widely-publicized and desirable benefits of telework is increased productivity. (Slaughter, 1996) This benefit is almost universally reported in the telework literature, although the actual percentage increase of productivity varies and the techniques used to determine the reported increases are not clear (Huws, et. al., 1990). While the benefits realized from using telework vary depending upon how it is implemented, any benefits gained would increase the competitive position of an organization. (Nilles, 1997) With respect to telework and competitiveness, for example, Borg-Warner Chemicals, Inc. believes that their implementation of telework has made them a more competitive company (Miller, 1986). O'Leary (1991) also reports that The Travelers considered the competitive ramifications of telework from its inception. Texaco reports similar positive outcomes and has prescribed infrastructure guidance for similar firms interested in telework. (DeSanctis, 1996) Greenhalgh (1995) reports on a similar corporate infrastructure for support of teleconferencing. Romei (1992) cites a study of managers at Fortune 500 companies who consider competitive advantage as an important benefit of telework. In a more competitive environment an organization should be expected to consider the use of *any* innovation which would give them a competitive advantage;

therefore, there should be a positive relationship between the competitiveness of the external environment and the adoption of telework.

In a similar manner, if in fact competitive benefits result when telework is adopted, then greater competitive advantage can be gained by diffusing the innovation more fully throughout the organization. (Gray, 1996) Therefore, a positive relationship should also exist between the competitiveness of the external environment and the diffusion of telework.

### Implementation of Telework by Perceived Competitors

This variable concerns the knowledge that competitors have adopted telework. Abrahamson and Rosenkoph (1993) suggest that this knowledge may create bandwagon pressure to adopt the innovation. This bandwagon pressure can arise from either institutional bandwagon pressures or from competitive bandwagon pressures. Institutional bandwagon pressures result from the threat of lost legitimacy, while competitive bandwagon pressures arise from the threat of lost competitive advantage (Abrahamson & Rosenkoph, 1993).

Consistent with this concept is the finding by Grover (1993) that the clear factor that stood out in the adoption of customer-based interorganizational systems was that organizations in industries where these systems are prevalent tend to be more likely to adopt them. Since organizations can not allow their competitors to gain these advantages unchallenged, a positive relationship between both the adoption and diffusion of telework and the implementation of telework by competitors is hypothesized. (O'Neill, 1998)

### Globalization of the Marketplace

Globalization of the marketplace will, by definition, require learning to work at a distance. (Spinks, 1996) Those most sensitive to this fact, perhaps by having implemented telework, with its telecommunications tools and workstyle, will be in a position to exploit this trend to their competitive advantage. Alternatively, those organizations with positive experience with telework may be more comfortable with attempting to globalize their marketplace, resulting in a positive relationship between both telework adoption and diffusion and a perceived globalized marketplace. (Higa, 1996)

### Communication with External Consultants

The extent and type of external communication is an oft-studied innovation variable (i.e., Rai, 1995; Zmud, 1983). This external communication may include publications, seminars, use of consultants, and contacts with educational and professional organizations as conduits to receive and disseminate information about an innovation.

Rai (1995) found a positive relationship between external communications and the adoption and implementation of CASE in information systems departments. In our study, a positive relationship is proposed between communication with outside consultants and the adoption of telework. However, once telework has been adopted, internal experience with telework would be expected to be much more relevant

Hypothesis	Expected Influence on Adoption	Expected Influence on Diffusion
Competitiveness of the Marketplace	+	+
Implementation of Telework by Perceived Competitors	+	+
Globalization of the Marketplace	+	+
Communication with External Consultants	+	N/A
Existence of Regulatory Legislation	+	+
Perceived Shortage of External Labor Supply	+	+
Perceived Sensitivity to Environmental Issues	+	+

**Table 1: Summary of Hypotheses**

than external information; therefore, no relationship between communication with consultants and telework *diffusion* is proposed.

#### **Existence of Regulatory Legislation**

Several types of regulatory legislation have the potential to impact telework. These laws can be at the local, state or federal level. For example, an important impetus for the adoption of telework in many California companies was the California Clean Air Act of 1990 (Dutton, 1994). At the federal level, the Clean Air Act, the American Disabilities Act and the Family Leave Act all require compliance which can be at least partially achieved through the use of telework (Lavalley, 1993). The state legislature in Arizona has imposed travel reduction laws on firms with 100 or more employees. These firms must reduce employee travel by five percent per year.

Therefore, it is hypothesized that there will be a positive relationship between legal mandates and both telework adoption and telework diffusion. This is because the adoption and the diffusion of telework is an easy and visible way for organizations to make efforts to at least partially comply with these laws. The most strict legislative mandates can be expected to be accompanied by the highest incidence of employees actually teleworking and telework thus becoming fully diffused within an organization.

#### **Perceived Shortage of External Labor Supply**

Much of the telework literature also discusses an increased supply of labor as one of the benefits of telework (Riley, 1996; Ouelette, 1998). Since telework may not require an employee's physical presence, employees can be recruited from a larger geographical area than is possible if a daily commute is required.

Tannenbaum and Dupuree Bruno (1994) studied the relationship between external labor supplies and innovative human resources practices and found that a positive relationship existed. A similar positive relationship is proposed for both the adoption and diffusion of telework.

#### **Perceived Sensitivity to Environmental Issues**

The decreased use of oil, decreased pollution emissions and lower upkeep expenses for the highway infrastructure are all examples of ecological environmental objectives that can potentially be partly achieved through telework. The importance to business of sensitivity to these ecological issues is

increasing, even in obtaining financing. There are investment funds which are designed to invest only in companies which demonstrate environmental responsibility as well as other types of corporate responsibility.

Telework offers companies an opportunity to fulfill their corporate responsibility to the environment in a positive way. Use of telework has the potential to reduce oil and gas consumption, to reduce polluting emissions and to reduce the wear and tear on the infrastructure while simultaneously providing a positive image for the company. Therefore, it is hypothesized that there will be a relationship between an organization's expressed concern for the ecological environment and the adoption of telework. Also, the greater the number of people who telework, or the greater the diffusion of telework, the greater will be the conservation of the environment. Table 1 summarizes all the hypotheses that have been developed above.

## **Methodology**

### **Survey Procedures and Outcomes**

Data were collected using a mail survey technique that was national in scope. The survey targeted IS professionals who either head an IS firm or are the top IS executive of an information systems department. Mailing lists were obtained from a computerized database on Dialog, from the professional organization Office Automation Society International (OASI), and from Applied Computer Research, Inc. Since this study was designed to explore the *organizational* adoption and diffusion of telework among IS professionals, the top IS executive was targeted as the appropriate respondent, as this is the person most likely to have a full and accurate policy view of all IS activities.

Since the intent of this survey was to focus on IS professionals, particularly programmer/analysts, a high proportion of the respondents work in IS businesses. The respondents represent the following industries in the following proportions: manufacturing, 23 percent; IS businesses, 42 percent; government, 10 percent; services, 10 percent; education, 5 percent; and business type not reported, 10 percent.

### **Descriptive Statistics Results**

Of the 1,601 top IS executives surveyed, 264 responded, resulting in 252 usable surveys, netting a response rate of 15.7%. Of the firms who responded that they had adopted telecommuting, 16 firms had 1-15 employees, 21 employed



Percentage of our staff who never telework	73.4%
Percentage of our staff who occasionally teleworks	15.0%
Percentage who telework equivalent of 1 day a week	3.9%
Percentage who telework equivalent of 2 days a week	1.8%
Percentage who telework equivalent of 3 days a week	1.4%
Percentage who telework equivalent of 4 days a week	0.6%
Percentage who telework equivalent of 5 days a week	3.8%

**Table 2: Descriptive Data of Incidence of Telework Among Respondents**

16-50, and 82 more than 50. For those firms with zero telecommuting activity, there were 23 in the 1-15 category, 11 in the 16-50 group, and 98 in the >50 group. Non-response bias was checked for the IS firms by size and geography and no significant departures from expectations were noted. This is consistent with the sampling experience reported in Harrington (1996). The non-response bias for IS departments was also checked by industry and again no significant differences were found. Those surveyed were asked to return the survey regardless of whether or not any employees in their organization telework. As a result, 120 respondents (48%) indicated that the firm allowed some degree of teleworking, whereas 132 respondents reported no telework activity whatsoever. (Independent contractors were not included in this survey since it focuses on regular employees of the company who substitute telework for working at the normal worksite.) The average frequency of teleworking among adopters of telework arrangements is given in Table 2 below.

As can be seen by the average frequency of teleworking among adopters, only a small percentage of the total IS effort is done using telework. Note also that full-time (5 days/week) telework is more common than teleworking 2, 3 or 4 days. This may suggest that those who telework full-time do so for reasons of need, such as geographical limitations or disabilities. In general, however, the sparse incidence of telework indicated by these data confirm the widespread anecdotal belief that telework has not “caught on.”

#### Measurement of the Dependent Variables

Telework adoption and telework diffusion were the dependent variables. Adoption data were obtained from a series of survey questions in which respondents reported the percentages of employees who telework and their corresponding equivalent number of days teleworked per week. Based on these data, “adopters” were defined as organizations who had even one employee teleworking, while non-adopters were those for whom 100 percent of the employees never teleworked. Diffusion was measured using a two-dimensional response matrix similar to that used by Nilakanta and Scamell (1990) and Rai and Howard (1994). A diffusion value for each respondent was calculated as a weighted average based on the reported percentage of the employees who telework and an encoded average number of days teleworked. A sample of the dependent variable measure, along with an example of how the dependent variable measure was calculated, is included in

	Mann-Whitney U Test		
	Adopters	Nonadopters	p-value
	Median Rank	Median Rank	
Competitive Markets	143.30	109.33	<b>0.0001</b>
Competitors Implemented	137.52	111.63	<b>0.0028</b>
Globalization	145.49	109.23	<b>0.0001</b>
External Communication	122.88	128.85	0.4989
Legislation	137.80	116.23	<b>0.0177</b>
External Labor Supply	135.12	118.67	0.0721
Sensitivity to “green”	129.98	123.33	0.4659

**Table 3: Results of Telework Adoption Analysis**

Appendix A.

#### Measurement of Independent Variables

The independent variables were measured using seven-point Likert scales designed to capture the perceptions of the top IS executive on each of the variables. Where feasible, multiple questions were used and averaged to determine the score for each variable. The actual questions used can be found in Appendix B. The reliability coefficients for these questions are available in the diagonal of the Kendall’s Correlation Coefficients matrix (Table 4).

### Analysis and Results

The tests of hypotheses were performed using nonparametric statistics. Because multiple mailing lists were used in this study, the distributions of the underlying populations can not be known with certainty. In such cases, parametric statistics, which impose special requirements on the compositions of the populations from which the samples are drawn and on the samples themselves, are inappropriate (c.f. Pierce, 1970). Also, in some cases the level of measurement was ordinal. Therefore, nonparametric techniques were more appropriate.

#### Adoption of Telework

The appropriate non-parametric test for comparing two populations, the equivalent of the parametric t-test, is the Mann-Whitney U test (Conover, 1980). Therefore, the Mann-Whitney U test was used to detect the relationships between the adopt/nonadopt dependent variable and the independent variables. The results of this analysis for each variable are given in Table 3, below.

These data show that adoption of telework is significantly ( $p < .05$ ) related to market competitiveness, implementation of telework by market competitors, globalization, and the existence of legislative mandates. No relationship was found between telework adoption and external communication with consultants, the external labor supply, or firms’ sensitivity to ecological issues.

#### Diffusion of Telework

In the case of the dependent variable “diffusion,” the appropriate nonparametric correlational analysis used was

Kendall Correlation Coefficients								
1	-							
2	0.1323	-						
	0.047	-						
3	0.2115	0.0844	(0.72)					
	0.002	0.121	-					
4	-0.0002	0.0431	-0.0472	-				
	0.499	0.285	0.255	-				
5	0.0199	0.1363	0.1442	0.3054	(0.64)			
	0.395	0.029	0.018	0.000	-			
6	-0.0409	-0.0051	0.0433	0.1796	-0.0160	(0.64)		
	0.291	0.472	0.262	0.006	0.406	-		
7	-0.0330	0.1966	0.1194	0.2082	0.3401	0.0130	(0.68)	
	0.330	0.003	0.041	0.002	0.000	0.424	-	
8	0.0624	0.2439	-0.0568	-0.1892	-0.0509	-0.0809	0.0011	-
	0.195	<b>0.000</b>	0.196	<b>0.003</b>	0.221	0.109	0.494	-
	1	2	3	4	5	6	7	8

(Cronbach's alpha coefficients (where appropriate) are shown in the diagonal.

Note: The first number shown represents the correlation coefficient.  
The number below it is the two-tailed p-value.

1. Competitive Markets
2. Competitors Implemented
3. Globalization
4. External Communication
5. Legislation
6. External Labor Supply
7. Sensitivity to "green"
8. Diffusion

Table 4: Results of Telework Diffusion Analysis

Kendall's Tau. This correlation procedure has the capability within its algorithms to adjust for tied values better than Spearman rank correlations analysis (Daniel, 1990). The Kendall's Tau sample statistic also provides an unbiased estimator of a population parameter, unlike the sample statistic calculated using Spearman rank correlations (Daniel, 1990). Since Kendall's Tau also provides information about the direction of the relationship, it was used to determine the correlational values between the independent variables and the dependent variable "diffusion." The results of this analysis appear in the correlation table (Table 4).

As the matrix shows, the only significant ( $p < .05$ ) correlates of telework diffusion were implementation of telework by market competitors and external communication with consultants. This is consistent with the expectation stated earlier that external factors would have a much greater influence of adoption of telework than on diffusion. Once an innovation has been absorbed into an organization, its subsequent patterns of implementation and use inside that organization are mainly dependent on internal factors, and largely insulated from what happens on the outside.

#### Adoption and Diffusion Results

As hypothesized, a competitive marketplace was found to be significantly related to the adoption of telework, presumably because the performance pressures imposed by high competition prompt companies to try everything possible that may potentially lead to cost-effective operation, including

telework. However, no significant relationship was found between a competitive marketplace and the diffusion of telework. Once telework is adopted, how widely it is diffused does not appear to depend on the external competitive environment. However, known implementation of telework by competitors is significantly related to both the adoption and diffusion of telework in organizations, as hypothesized.

Globalization of the marketplace was also significantly related to the adoption of telework. This finding, together with the findings for competitiveness, suggest that telework may be adopted based on a perceived *defensive* need, based on external competitive pressures and the "bandwagon" effect.

There was no significant relationship between external communications with consultants and the adoption of telework. This finding, with that of Zmud (1983) that the relationship between external information channels and software group innovativeness is contingent on the internal environment's conduciveness to innovation, suggests that the internal environment in many organizations may be equally non-conducive to the adoption of telework.

The relationship between communications with external consultants and diffusion was found to be significant, but in a negative direction. Apparently, firms with the most communications with consultants are teleworking the least. It may be that consultants are advising very measured, cautious entry into telework implementations. Many experts advise that telework programs be well-planned and be preceded by careful pilot tests and extensive employee training. Perhaps orga-

nizations are heeding this advice and are therefore still in the early stages of implementation. This finding is also consistent with Hoffer and Alexander (1992) who found that the extent of implementation of database machines was inversely correlated with the awareness of database machines. They suggest that a greater awareness of database machines led to greater skepticism.

The existence of regulatory legislation was found to be significantly related to the adoption of telework as hypothesized. However, this variable was not found to be related to the diffusion of telework.

External labor supply adequacy was not found to be significantly related to either the adoption or diffusion of telework. This finding was surprising given the recruitment and retention benefits often cited for telework, especially in the anecdotal literature. The finding is also a surprise given the present wide shortage of technical personnel and the potential of telework opportunities to entice those scarce employees into employment with teleworking organizations. It is not clear whether there is skepticism concerning the link between telework and this recruitment and retention strategy or whether labor supply is simply not an issue for those employing programmer/analysts.

Sensitivity to environmental issues also was not found to be related to either the adoption or diffusion of telework. The ecological environmental impact of telework does not appear to be a concern to organizations involved in telework, possibly because the tie between environmental responsibility and hard-line profitability is still too tenuous. However, this variable may be appropriate when studying the adoption of telework at the individual level.

### Limitations of this Study

This study was conducted by asking information systems managers about the programmer/analysts in their firms and departments. The job of programmer/analysts was chosen because it is often cited as ideally suited to telework. (Davis, 1991; DeSanctis, 1983; Nilles, 1992) Also, information systems professionals should already be comfortable with the kinds of technology needed to support telework. Therefore, any attempt to generalize the results of this study beyond information systems professionals who work in an IS setting should be undertaken cautiously.

Also, this study was not designed to be all-inclusive of the environmental forces which may effect the adoption and diffusion of telework. Rather, it was designed to examine particular environmental factors expected to be most relevant to an entire organization rather than to individuals working within that organization. Other environmental factors such as availability of public transportation systems and the availability of ISDN may also have an impact of the growth of telework. Also, the length of commuting time may have an impact on the decision of individual workers to telework.

Another caution is that since the study is cross-sectional it suffers from the traditional shortcomings of this type of research, most particularly that trends over time cannot be

analyzed.

Finally, it is important to note that some of the independent variables exhibited significant intercorrelations. Referring to Table 4, for example, it is seen that "Competitive Markets" and "Globalization," "External Communication" and "Legislation," and "Legislation" and "Sensitivity to Green," intercorrelate significantly. These intercorrelations attenuate the strength of the correlations found with the dependent variable. These results suggest a follow-on study that seeks to clarify the factor structure of the environmental variables that have been suggested to be relevant by the literature.

### Implications for Practice and Research

A competitive marketplace, a globalized marketplace, the existence of regulatory legislation and a competitor's implementation of telework all significantly affect the adoption of telework. These findings confirm our overall expectation that external environmental factors may relate significantly to the adoption of telework.

The connection between external innovation-inducing forces and actual innovation behaviors in-house influence the strategy an organization will follow to implement an innovation. For example, Marcus and Weber (1989) found that when innovation adoption is externally induced, the appropriate strategy for implementing that innovation should be "autonomy" rather than a rule-based approach. Within the autonomy approach, managers have control over whether and how the innovation is introduced within their sections. In a rule-based approach an innovation is mandated organization-wide — the innovation's implementation is less discretionary. Thus, the connection between external inducers and internal innovation might be less direct under the "autonomous" approach because some managers may opt not to employ the innovation.

This choice of implementation strategy is particularly relevant to the growth of telework (Gray, 1997). It is frequently reported that the major barrier to the adoption of telework is managerial attitude (Currid, 1992; Harier, 1993; Huws, et al., 1990; Sixel, 1994). Marcus and Weber (1989) suggest that implementation is more effective if policy implementers are free to design and determine the specifics of how implementation takes place ("autonomous" approach). If a large proportion of managers in an organization are cynical about a particular innovation, and if that organization implements autonomously, it is possible that very little actual innovation adoption will occur.

Telework can be implemented in a number of scenarios and employees can telework from occasionally to full-time, thus providing managers with great flexibility in implementation levels. However, our descriptive statistics indicated that even among firms with teleworkers, an average of 73.4 percent of the employees never telework, and another 15 percent telework only occasionally. Also, telework's implementation appears to be bottom-up since approximately 80 percent of the

arrangements reported are on an ad-hoc basis with approximately 84 percent of the arrangements being informal. This suggests that telework is not currently being implemented as corporate policy or a rule-based policy but through a large number of individually negotiated employee-supervisor deals. These data suggest that far more telework implementations are occurring within autonomous rather than rule-based implementations. As expected, this autonomous method of implementation, as found to be appropriate by Marcus and Weber (1989), does not appear to have led to the rapid growth of telework.

These findings concerning telework adoption, together with the finding that there is a high correlation with implementation of telework by competitors, suggests that telework adoption may also be influenced by a bandwagon effect. Abrahamson and Rosenkoph (1993) point out that this effect explains why potentially beneficial innovations such as telework are not adopted or diffused, while inefficient innovations are widely adopted and diffused. In the case of telework, the bandwagon pressures should be studied to determine the proper bandwagon effect. Abrahamson and Rosenkoph (1993) also stated that ambiguity is the main moderating factor impacting the number of adopters and the strength of bandwagon pressures. There are several types of ambiguities and a relevant one they identify is the ambiguity of means-ends relations or the lack of clarity regarding both the range of possible outcomes of actions and the probability of each outcome's occurrence. A longitudinal study that tracks the introduction of an innovation in one organization and its subsequent spread to other similar organizations would be very useful in capturing an understanding of this hypothesized bandwagon effect and whether it is a rational process.

The finding of a negative relationship between adoption and external communication with consultants suggests that experts do not appear to reduce the ambiguity. Just as Hoffer and Alexander (1992) found that awareness of database machines may have led to skepticism, a similar effect may occur with telework. Dvorak (1994) suggests that telework should be actively promoted by those who have used it successfully. While this may reduce ambiguity, championing telework must be accomplished in such a way that it is not perceived as "too good to be true." Reports of telework's successful use in business situations may be the appropriate strategy if the reports are factual and contain both the positive outcomes and the situations and implementation strategies which led to its successful use.

Also, the fact that once the decision to adopt telework is made, the knowledge that competitors have implemented telework arrangements has a positive affect on how widely telework is diffused. This further confirms that telework may be susceptible to the bandwagon effect. However, even when studying an external bandwagon effect, the external environment must be considered.

The variables affecting the adoption of telework such as a competitive marketplace, a global marketplace, competitor's implementation, and the existence of regulatory

legislation all imply that external environmental factors or jolts have an important role to play in the adoption of telework. Also, as suggested by Marcus and Weber (1989), these jolts have an important role in the type of implementation necessary to maximize the diffusion and therefore growth of telework.

This effect may be supplemented in the future with regulatory legislation as enforcement deadlines approach, particularly if the benefits of telework become more widely known and accepted. As companies search for methods to comply with these legislative mandates, telework may present a very beneficial solution.

Adoption of telework is subject to the influence of outside forces such as the competitive environment and the globalization of the marketplace, implementation by competitors, and regulatory legislation. Those wishing to champion telework in their organizations would be well-advised to suggest that their organization experiment with telework prior to outside forces inducing its adoption. This would allow the implementation strategy of autonomy suggested by Marcus and Weber (1989) to be used, subject to the caution that this strategy may not lead to the most rapid growth of formal teleworking programs.

Telework studies are also needed which take an individual perspective. In particular, the attitude of individual managers should be explored to determine if they should be given autonomy in the implementation process. Also, the nature of a possible bandwagon effect should be explored further. The lack of a significant "critical mass" to trigger the telework bandwagon may explain, in part, why telework has not grown as expected. Part of the necessary trigger would be wide dissemination of the results of additional empirical studies which quantify the benefits of telework. Such studies could potentially be very valuable in accelerating the adoption and diffusion of telework, thus allowing organizations to capture its potentially large and widespread macroeconomic benefits.

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## APPENDIX A: Adoption and Diffusion Measure

	Example	Your Responses
Percentage of our staff who never telework	30%	
Percentage of our staff who occasionally, but not regularly telework	15%	
Percentage who regularly telework an equivalent of 1 day a week	30%	
Percentage who regularly telework an equivalent of 2 days a week	20%	
Percentage who regularly telework an equivalent of 3 days a week	5%	
Percentage who regularly telework an equivalent of 4 days a week	0%	
Percentage who regularly telework an equivalent of 5 days a week	0%	

Notes on measures:

**Adoption** - Adopters are respondents who have any percentages in any category other than the "Percentage of our staff who never telework" category.

**Diffusion** - The frequency levels of telework have been coded to range from zero for the first level (never telework) to 6 for the last level (equivalent of 5 days a week). These codes are then weighted by the percentage of workers at each level.

From the sample data above, 30% of the staff never telework, 15% telework only occasionally, 30% do so an equivalent of one day a week, 20% two days a week, and 5% three equivalent days a week. Thus, the calculation would be:  $0.30*0 + 0.15*1 + 0.30*2 + 0.20*3 + 0.05*4 + 0*5 + 0*6 = 1.55$ .

## APPENDIX B: Programmer/Analyst Telework Questionnaire

### THE DEFINITION OF TELEWORK:

Work done only during normal hours at a site other than the normal worksite.  
Work done after hours is not telework.

Excerpt from cover letter:

Telework/telecommuting, for this study, concerns employees who work at a site other than the "normal" worksite. For example, if an employee *usually* works at another location, that is not telework. However, if an employee works from home or an alternate office, he/she is defined to be a teleworker. This study looks at those factors the literature suggests are related to the decision to adopt teleworking among programmer/analysts. *It is important to complete the indicated portions of the questionnaire even if you do not currently have any programmer/analysts teleworking, so that we may identify differences between those firms who have teleworkers and those who do not.*

Strongly Disagree	Disagree	Disagree Slightly	Neutral	Agree Somewhat	Agree	Strongly Agree
SD	D	DS	N	AS	A	SA

Please circle on the scale at the right (see above) the choice that best represents the situation in your firm. Please be sure to answer all questions.

1. The firm is involved in an industry which has a global marketplace. (GLOBALIZATION)
2. This firm is trying to expand our markets to non-U.S. markets. (GLOBALIZATION)
3. This firm is in a highly competitive market. (COMPETITIVENESS)
4. We have competitors who we know have implemented teleworking arrangements. (COMPETITORS IMPLEMENTATION)
5. We expect there to be a shortage of programmer/analysts in the future. (EXTERNAL LABOR SUPPLY)
6. We have difficulty finding qualified programmer/analysts. (EXTERNAL LABOR SUPPLY)
7. People in this firm have learned about telework from consultants and their newsletter. (EXTERNAL COMMUNICATIONS)
8. This firm feels that environmental issues are important. (ENVIRONMENTAL ISSUES)
9. This firm has company policies regarding environmental issues. (ENVIRONMENTAL ISSUES)

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Cynthia P. Ruppel, Assistant Professor, College of Business, The University of Toledo, Toledo, OH, received her Ph.D. in Management Information Systems from Kent State University. Her interests include telecommuting and other forms of virtual work arrangements, IT innovation adoption and diffusion, as well as organizational culture/climate and change management. She has published in *DATABASE for Advances in Information Systems*.

Geoffrey S. Howard, College of Business, Kent State University, received a D.B.A. in MIS from Kent State University in 1984. Dr. Howard studies offshore programming in small island nations, the functional displacement of late-career programmers, the diffusion of innovation, telecommuting and virtual corporations, and computer anxiety and technophilia. Prior to coming to Kent, he accumulated 15 years of industry experience in electrical engineering and system development. He has published his work in *Decision Sciences*, *Communications of the ACM*, *The Journal of Systems Management*, *The Computer Journal*, and other academic outlets. He was selected twice as one of the top ten teaching professors at Kent State University, has been inducted repeatedly into Mortar Board for excellence in classroom teaching, and was the first winner of the Paul Pfeiffer Award for Creative Excellence in Teaching. Dr. Howard is a Registered Professional Engineer in the State of Ohio.

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