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ABSTRACT

The unevenness in the diffusion rates of the Internet across nations is commonly referred to as the "digital divide." Technological, economic and political factors are often mentioned as the primary contributing factors to this digital gap. However, there is sufficient evidence in support of the proposition that a nation's culture also plays a role in how citizens adopt and use technology innovations. This paper examines the relationship between the cultural dimensions proposed by Hofstede and the Internet adoption rate of nations. Data from sixty-two countries are used to establish a regression model and the empirical results show that cultural traits such as "uncertainty avoidance" and "masculinity" index of a nation are significantly related to the nation's Internet diffusion rate. These findings suggest that policy makers must also consider these national culture traits along with technological, economical, and political factors in setting national policies to promote Internet-related innovations.

INTRODUCTION

There is considerable evidence to support the notion that the diffusion of information and communication technologies in concert with appropriate economic, intellectual property protection, and infrastructure improvement policies contribute to the acceleration of economic growth. For example, in Australia, Canada, Finland and the United States, investments in information technologies (IT) during the past decade have led to substantial economic growth (Lawrence, 2002). The rapid adoption of the Internet and subsequent business applications (e.g., e-business) are often touted as leaders in driving this growth spurt (Dedrick, Gurbaxani, & Kraemer, 2003; Forestier, Grace, & Kenny, 2002; Kenny, 2003; Koh & Chong, 2002). Such benefits include lower transaction costs, less price dispersion, broader and integrated competitive markets, and seamless communication capabilities.

In spite of the fact that the Internet and resulting business applications provide unique economic growth opportunities, in many countries Internet diffusion rates continue to be low. For example, the Internet subscription rates remain below 1% in countries such as Bangladesh, Nigeria, Vietnam, and Zimbabwe (International Telecommunications Union, 2002). On the other hand, these figures are above fifty percent in countries such as the United States, Sweden, and Iceland. Then, why is it that certain societies adopt innovations far quicker than others? Obviously, some societies are risk averse, more conservative and resist changes than others. Is it the culture of the people that plays a significant role in how people adopt and use innovations and specifically information technology innovations? There is ample evidence in support of the notion that culture does indeed matter.

For innovations such as cell phones, home computers, and microwave ovens, using data from 19 countries, Yaveroglu and Donthu (2002) found that technological innovation is high in countries with low power distance, low uncertainty avoidance, and high individualism – cultural dimensions developed by Hofstede (1980, 1991). In another study, Yeniyurt and Townsend (2003) investigated the role that culture plays in the acceptance of new products. Their findings indicate that lower acceptance of new products is related to power distance and uncertainty avoidance cultures and the moderation effects of socio-economic variables on acceptance are mixed. With respect to the adoption of Enterprise Resource Planning (ERP) software, national culture is shown to have a significant influence on its adoption rate (van Everdingen & Waarts, 2003). Further, a study by Tsikriktsis (2002) found that masculinity and long-term orientation are significantly associated with web site quality expectations. Cultural considerations even play a role in how information systems, in general, are designed, implemented, and used (Gallupe & Tan, 1999; Nelson & Clark, 1994; Watson, Ho, & Raman, 1994; Straub, 1994; Montealegre, 1997; Jarvenpaa & Leidner, 1998). For instance, Straub (1994) showed that in Japan, workers prefer Fax over e-mail because of the intricacies of the Japanese language and other cultural factors. However, this phenomenon was not evident in the United States. In yet another study, Linjun, Ming-Te and Wong (2003) have shown that power distance plays a substantial role in the acceptance of e-mail in the People's Republic of China. Furthermore,

Jarvenpaa and Leidner (1998), using a case study in Mexico, note that the success of an information system hinges on a good understanding of the national culture and local environment during the implementation stage of the project. In fact, the importance-of-culture argument has been made a long time ago – Barnett (1953) noted, "....cultural psychological social and institutional arrangements must first exist before people will be moved to obtain, create, use, and exploit technology to their benefit." For a comprehensive discussion on the role of culture on various information systems issues the reader is referred to a study by Ford, Connelly and Meister (2003).

There is a considerable dearth of published research that specifically examines the role of culture in the adoption of the Internet. The purpose of this paper is to fill this void. In addition to investigating the relationship between the national culture (as measured by Hofstede's cultural dimensions) and the Internet diffusion rate, this research also incorporates variables that measure technological, economic and political factors.

HOFSTEDE'S CULTURAL DIMENSIONS

Culture is defined as: "the collective programming of the mind which distinguishes the members of one human group from another (Hofstede, 1991, p.5)." In his book titled *Culture's Consequences,* Hofstede (1980) suggested four dimensions of culture. These four dimensions are based upon a study of 72,215 employees working in 66 national subsidiaries of IBM Corporation between 1967 and 1973. The dimensions are power distance, individualism-collectivism, uncertainty avoidance, and masculinity-femininity. Later on a fifth dimension was added – long-term orientation (Hofstede and Bond, 1988).

Researchers in business, psychology and sociology have extensively used Hofstede's framework. Several studies have confirmed Hopfstede's framework (Barkema & Vermeulen, 1997; Hoppe, 1992; Shackleton & Abbas, 1990). However, there are others who contend that Hofstede's conclusions may not be valid in the long term (Igbaria, Iivari, & Maragahh, 1995; Kamel & Davison, 1998; Levitt, 1983; Nordstrom, 1991; Myers & Tan, 2002; Ohmae, 1985; O'Reilly, 1993; Roberts & Boyacigiller, 1984; Triandis, 1982). Major concerns center around the notion that cultural and societal values are converging over time and thus, Hofstede's cultural dimensions are no longer valid in adequately explaining cultural differences. Some argue that the Internet and accompanying advances in communication technologies have accelerated the homogenizing effect and hastened the cultural convergence (CPSR, 1997; Deen, 1999; Lee, 1998).

In spite of these criticisms, Hofstede's framework remains useful in theory development and validation in cross-cultural studies. Also, its impact in the fields of international business, marketing and management is well documented (Chandy & Williams, 1994; Sivakumar & Nakata, 2001; Sodergaard, 1994). In light of this evidence in support of Hofstede's framework, it is useful to employ the proposed cultural dimensions in studying the relationship between a national culture and Internet diffusion rate. These cultural dimensions are briefly described below:

Power Distance (PD): Power distance is defined as "the extent to which the less powerful members of institutions and organizations within a country expect and accept that power is distributed unequally" (Hofstede, 1991, p.27). In cultures with high power distance, decisions are centralized and subordinates are often fearful of disagreeing with their superiors. On the other hand, cultures with low power distance are more participative and have less tolerance for the lack of autonomy. In a society with low power distance, we expect people to be more innovative and willing to try new things.

Individualism versus Collectivism (IND): This dimension relates to the way people live together. Individualism "pertains to societies in which the ties between individuals are loose: everyone is expected to look after himself or herself and his or her immediate family" (Hofstede, 1991, p.51). On the other hand collectivism "pertains to societies in which people from birth onwards are integrated into strong, cohesive groups, which throughout people's lifetime continue to protect them in exchange for unquestioning loyalty" (Hofstede, 1991). Cultures with high individualism value personal time and achievement. Such societies are expected to be more innovative and open to new ideas.

Uncertainty Avoidance (UA): Uncertainty avoidance refers to "the extent to which the members of a culture feel threatened by uncertain or unknown situations" (Hofstede, 1991, p. 113). A culture high in uncertainty avoidance is rule oriented, has less tolerance for opinions and behaviors different from its own, and avoids taking risks. There is

also resistance to change. Cultures with high uncertainty avoidance are expected to be less innovative and less accepting of new things.

Masculinity versus Femininity (MAS): This is possibly the most controversial dimension of culture advocated by Hofstede. In highly masculine cultures "men are supposed to be assertive, tough and focused on material success; women are supposed to be more modest, tender and concerned with the quality of life" (Hofstede et al.,1998). The more modern and popular perspective on this dimension is to view the masculine and feminine culture in terms of competitiveness and material success versus nurturing behavior and quality of life, as opposed to gender roles for the sexes.

Long term versus Short Term Orientation (LTO): The long-term orientation refers to the orientation towards the future. Long-term orientation cultures are represented by values such as prestige, ordering relationships by status and observing this order, and having a sense of shame. Short-term orientation is represented by respect for tradition, and reciprocation of greetings, favors, and gifts (Hofstede, 1991, p. 165). This dimension originated from the work of Michael Bond of Chinese culture. It was first named "Confucian Dynamism" and was later renamed by Hofstede as long-term versus short-term orientation. Countries with long-term orientation look into the future and they are risk averse -- they are less prone to innovate.

As mentioned previously, the main objective of this research is to ascertain the relationship between the national culture as measured by Hofstede's cultural dimensions (PD, IND, UA, MAS, and LTO) and the Internet diffusion rate.

METHODOLOGY

The main purpose of this research is to examine the relationship between the national culture and the Internet diffusion rate. However, since other factors beside culture may influence the Internet adoption rate, certain technological, economic and political variables are also considered as control variables. In a recent study, Nath and Murthy (2003) have shown that the cost of Internet access, innovativeness, and the degree of economic freedom play a key role in determining the nation's Internet subscription rate. A brief description of the variables considered is provided below:

- DIFF: Internet diffusion rate. This variable is measured as the percent of a nation's citizens with Internet access.
- PC: Number of personal computers per 100 inhabitants.
- TEL: Telephone lines per 100 inhabitants.
- CELL: Cell phone subscribers per 100 inhabitants
- ITCOST: Average monthly cost of 20 hours of Internet access.
- INCOME: Real gross domestic product per capita (in U.S. purchasing power parity $).
- INNOV: Innovative capability of the country. This variable is calculated as the product of the number of patents granted per million inhabitants in the year 2000 and gross tertiary enrollment rate in 1997. Note that the number of patents reflects the nation's innovation intensity and the enrollment rates denote the degree of investment in human capital. Thus, INNOV measure reflects a country's capability and capacity for innovation in technologies and products (McArtur & Sachs, 2002).
- EFI (Economic Freedom Index): Beach and O'Driscoll (2003) define this index as the ".... absence of government coercion or constraint on the production, distribution, or consumption of goods and services beyond the extent necessary for citizens to protect and maintain liberty itself." This index aggregates several factors covering broad issues such as corruption, non-tariff barriers to trade, the fiscal burden of government, the rule of law and efficiency of the judiciary, regulatory hurdles for businesses, labor market restriction, and black market activities. Complete details regarding the development and description of this index can be found in Beach and O'Driscoll (2003). The values of EFI can vary from 1 to 5. A value of 1 indicates set of national policies that promote economic freedom and a value of 5 signifies policies that are least conducive to economic freedom. This variable is recoded by subtracting it from six so that it still varies between 1 and 5 and also, larger values denote higher economic freedom and lower values indicate minimal economic freedom.
- PD: Power distance
- IND: Individualism-collectivism

- UA: Uncertainty avoidance
- MAS: Masculinity-femininity
- LTO: Long-term Orientation

Data on variables DIFF, PC, TEL, CELL, ITCOST, and INCOME were obtained from *The Global Information Technology Report 2001-2002*. The data to construct the variable INNOV (a combination of the number of patents and education levels) were obtained from *The Global Competitiveness Report 2001 - 2002*. The data on Economic freedom index (EFI) for various countries were taken from Beach and O'Driscoll (2003). As an additional check on the accuracy, these data were checked against the databases from the home pages of *The International Telecommunication Union* (2002) and *World Development Indicators* (World Bank, 2002). Furthermore, the data on Hofstede's cultural dimensions (PD, IND, UA, MAS, LTO) were obtained from the web site: www.geert-hofstede.com.

Data on most of the variables were available for 62 countries with the exception of LTO (long term orientation). The data on LTO were available only for 23 countries.

ANALYSIS AND FINDINGS

Descriptive Statistics

Table 1 summarizes the Internet diffusion rates (DIFF) of the sixty-two countries. Note that the diffusion rates vary considerably across nations. For example, eleven countries have diffusion rates below 1% (Bangladesh, Nigeria, Vietnam, Zimbabwe, Paraguay, Ukraine, India, Guatemala, Honduras, Sri Lanka, and Indonesia). On the other hand, three countries have diffusion rates exceeding 50% (Sweden, the United States, and Iceland). The diffusion rate average is 17% with a standard deviation of 18.2%.

Table 1. Internet Diffusion Rates

Diffusion Rate	n	%	Countries
< 1%	11	17.8%	Bangladesh, Nigeria, Vietnam, Zimbabwe, Paraguay, Ukraine, India, Guatemala, Honduras, Sri Lanka, Indonesia
1% - 3%	10	16.1%	Panama, China, Jordan, Thailand, Columbia, Russian Federation, Jamaica, Philippines, Mexico, Bulgaria
3 % - 5%	4	6.5%	Turkey, Trinidad &Tobago, Romania, Venezuela
5 % - 10%	9	14.5%	South Africa, Brazil, Argentina, Hungry, Poland, Mauritius, Latvia, Greece, Czech Republic
10% - 20%	5	8.1%	Chile, Slav Republic, Spain, France, Malaysia
20% - 30%	7	11.3%	Portugal, Italy, Austria, Belgium, Ireland, Taiwan, Germany
30% - 40%	6	9.7%	Japan, United Kingdom, Switzerland, Hong Kong, New Zealand, Finland
40% - 50%	7	11.3%	Korea, Canada, Australia, Netherlands, Singapore, Denmark, Norway
50% - 60%	3	4.8%	Sweden, United States, Iceland
Total	62	100%	

Table 2 provides descriptive statistics (mean, standard deviation, minimum, and maximum) for the variables considered. It is interesting to note that cost of 20 hours of Internet access (ITCOST) ranges from U.S. $2.59 in Sweden to U.S.$40.71 in Nigeria. Also, technology factors such as cell phones (CELL), fixed-line phones (TEL), and personal computers (PC) vary considerably among nations.

Table 2. Descriptive Statistics

Variable	n	mean	SD	min	max
DIFF (%)	62	17.00	18.23	0.04	60.00
CELL (%)	62	32.70	27.40	0.02	80.30
TEL (%)	62	33.08	23.07	0.34	75.25
PC (%)	62	16.71	17.43	0.09	58.52
ITCOST	62	16.59	6.73	2.59	40.71
INCOME	62	13,843	9,791	871	33,886
INNOV	62	3.30	1.62	1.00	6.84
EFI*	62	3.34	0.69	1.80	4.70
PD	56	56.27	21.54	11	104
IND	56	43.66	25.16	6	91
UA	56	65.04	23.88	8	112
MAS	56	50.09	18.00	5	95
LTO	23	46.74	28.53	0	114

*Reverse coded by subtracting EFI from six.

The inter-correlations among the thirteen variables including the dependent variable DIFF are shown in Table 3. It is interesting to note that all the variables except ITCOST, MAS, and LTO, are significantly correlated ($p < .01$) with the Internet diffusion rate (DIFF). Also, there exist significant correlations among the technology variables CELL, TEL, and PC. In addition, it is noteworthy that INNOV is significantly correlated with economic freedom (EFI), power distance (PD), and individualism (IND).

Table 3. Correlation Coefficients

	DIFF	CELL	TEL	PC	ITCOST	INCOME	INNOV	EFI	PD	IND	UA	MAS	LTO
DIFF	1.00												
CELL	0.81**	1.00											
TEL	0.88**	0.87**	1.00										
PC	0.95**	0.80**	0.89**	1.00									
ITCOST	0.22	-0.14	-0.18	-0.19	1.00								
INCOM	0.90**	0.88**	0.94**	0.94**	-0.15	1.00							
INNOV	0.81**	0.76**	0.86**	0.80**	-0.19	0.85**	1.00						
EFI	0.72**	0.73**	0.76**	0.75**	-0.10	0.80**	0.69**	1.00					
PD	-0.64**	-0.62**	-0.68**	-0.64**	0.08	-0.69**	-0.62**	0.61**	1.00				
IND	0.66**	0.50**	0.50**	0.69**	0.04	0.74**	0.67**	0.53**	-0.69**	1.00			
UA	-0.41**	-0.11	-0.14	-0.39**	0.11	-0.15	0.16	-0.06	0.24	0.18	1.00		
MAS	-0.28	-0.14	-0.17	-0.18	0.41**	-0.07	-0.13	-0.06	0.07	0.07	0.03	1.00	
LTO	-0.39	-0.03	-0.27	-0.40	-0.37	-0.34	-0.42	-0.26	0.33	-0.40	0.10	0.09	1.00

** Significant at the 0.01 level; *Significant at the 0.05 level

Regression Analysis

Next, in order to develop a comprehensive model that examines the effect of the explanatory variables, CELL, TEL, PC, ITCOST, INCOME, INNOV, EFI, PD, IND, UA, MAS, and LTO on the dependent variable DIFF, Ordinary Least Squares (OLS) regression analysis was performed. For the sake of having sufficient degrees of

freedom for a rigorous statistical analysis, the explanatory variable LTO was excluded, as we have data on LTO for only 23 countries. The correlation matrix shows (Table 3) that some of the explanatory variables might suffer from multicollinearity. One approach to addressing the multicollinearity problem is to first identify the culprit variables and then eliminate them from further consideration in the regression model. A commonly used measure to identify collinear variables is to compute the variance inflation factor (VIF[1]) of each variable (Myers, 1986). VIF of a variable indicates the extent to which the variance of the regression coefficient estimate is inflated due to the presence of multicollinearity. As a rule of thumb, if the VIF of an explanatory variable exceeds 10, the variable is considered to be highly collinear and it can be treated as a candidate for exclusion from the regression model (Kleinbaum, et al., 1988). In our analysis, two variables (TEL and PC) had VIF values that exceeded this threshold (12.05 and 16.10, respectively). Consequently, these two variables were excluded from further analysis.

Next, a stepwise regression analysis on the remaining variables resulted in retaining four explanatory variables, namely, UA, MAS, INCOME, and INNOV. Note that two of the four retained variables (UA and MAS) are culture variables. Table 4 reports the results of this stepwise regression analysis. The estimated model as a whole is statistically significant at the .01 level (F = 100.386; p = 0.000). Furthermore, the coefficient of determination, adjusted for degrees of freedom, R^2 is equal to 0.90, indicating that about 90% of the variation in the dependent variable, DIFF, is collectively explained by the four variables, UA, MAS, INCOME, and INNOV.

Table 4. Regression Results

Variable	Standardized Coefficient	Coefficient	t-value	p
UA	-0.187	-0.253	-4.900*	.000
MAS	-0.171	-0.178	-3.490*	.001
INCOME	0.001	0.539	5.060*	.000
INNOV	3.781	0.339	3.484*	.001
Constant	11.041	--	2.777	.040

$R^2 = 0.91$; F = 100.386*; JB[c] = 0.360

Dependent variable: DIFF.
* denotes significance at the one percent level.
t-values are computed using White's heteroscedasticity standard errors.
[c]JB is the observed Jarque-Bera value for the test of normality.

In order to test for the presence of normality in the estimated regression reported in Table 4, the Jarque-Bera (JB) coefficient was obtained. The observed JB value of 0.36, with a p-value of 0.84, shows that the error terms in the regression model follow a normal distribution. In addition, since the estimated model in this paper is cross-sectional model involving countries of different sizes, the possibility of heteroscedasticity or unequal variances given the chosen value of the explanatory variables, is always suspected. However, White's general heteroscedasticity test indicates that there is no heteroscedasticity in the estimated model.

Two culture variables, UA (uncertainty avoidance) and MAS (masculinity), have negative regression standardized regression coefficients with values of -0.253 and -0.178, respectively. This statistical evidence suggests that cultures that avoid uncertainty and risks (risk-averse) are resistant to the use of the Internet. In these societies, the cultural institutions are not conducive for Internet adoption. In addition, societies with high masculine culture tend to have lower Internet diffusion rates. It is also worth noting that both INCOME and INNOV have significant standardized positive regression coefficients (0.539 and 0.339, respectively). This empirical evidence

[1] $VIF_j = 1/(1 - R^2_j)$ where R^2_j is a measure of the degree of multicollinearity between X_j and other explanatory variables. Therefore, if $R^2_j = 0$, then $VIF_j = 1$, and if $R^2_j = 1$, then $VIF_j = \infty$.

indicates that nations with higher income levels and enhanced innovativeness tend to exhibit higher Internet subscription rates.

SUMMARY AND CONCLUSIONS

Research presented in this paper shows that, collectively, income level, innovativeness of the nation, uncertainty avoidance, and masculinity of a culture have significant impact on the Internet diffusion rate of a nation. First, the role of income in determining the Internet subscription rate is not surprising and, in fact, is consistent with the notion that having adequate level of income is a prerequisite for purchasing hardware, software, and acquiring access to the Internet. In spite of the many well-established benefits of information technology applications and the Internet, people in many countries simply cannot afford to buy required technology. Many nations are developing affordable computer systems for its citizens. For example, in India, a consortium of organizations have designed and built a simple, and less expensive computers called "Simputer" (stands for "simple, inexpensive, multilingual computer") (Harvey, 2002). Such innovations can be extremely helpful in empowering low-income segments of a nation's population with practical alternatives to expensive IT appliances.

Second, a nation's innovativeness positively affects Internet diffusion. This is not surprising as innovative societies tend to be very entrepreneurial and consequently, people take risks, try new things, and have a high propensity to make use of new and emerging technological innovations. Also, nations with good secondary and university education systems tend to enhance opportunities for innovation simply by harnessing the intellectual capital of its citizens.

Third, societies with high uncertainty avoidance tend to have lower Internet subscription rates. Certainly, in such societies, people are risk averse and unwilling to try new things. Also, the same pattern is observed in highly masculine societies. In these societies, since the entire population (male and female) does not actively participate in using the Internet, the observed negative relationship is meaningful. Adoption of the Internet is very sensitive to cultural factors, since it is perceived in many traditional societies as a threat to the traditional and well-established modes of doing things.

The findings of this research have many implications for researchers, practitioners, and policy makers. Researchers engaged in international information systems research need to take into account cultural considerations along with other relevant factors in gauging user behaviors and technology adoption patterns. Even when non-cultural factors stay constant, user technology acceptance rates can vary greatly from one society to another simply due to cultural differences. This information can significantly enhance the efficacy of research designs and their implementation in different settings. Using the same reasoning, practitioners must also consider the cultural attributes of the users during the design and implementation phases of IS projects. Ignoring these cultural factors could result in diminished user-acceptance and consequently, the full potential of the technology system cannot be attained.

At the national policy level, the findings of this research can provide some guidance to policy makers and politicians. First, a society's culture does matter in how its population accepts and uses the Internet. Second, cultures do not change in a short period of time and attempting to do so can cause social upheaval. However, policy makers can mitigate the effect of culture on the diffusion of the Internet by educating its citizens on the benefits of the technology in a cultural-sensitive fashion. For example, once people see how quickly and easily they can access information with direct benefit to them, they are more likely to accept the technological innovations like the Internet. Community-based Internet kiosks are another option that is cost effective and un-intrusive to many people. Furthermore, governmental policies that are information technology friendly and proactive can go a long way in bridging the digital divide gap. In the absence of carefully crafted strategies and plans by national governments and international organizations such as the United Nations, this gap is likely to worsen and leave a large segment of the world's population further behind on the economic ladder.

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