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Determinants of the Digital Divide in Rural Communities of a Developing Country: The Case of Malaysia*

MAHENDHIRAN NAIR | Monash University Sunway Campus
GIL-SOO HAN | Monash University
HEEJIN LEE | Yonsei University
PATRICIA GOON | Monash University Sunway Campus
RAMLAH MUDA | Monash University Sunway Campus

The computer is regarded as an important tool for the socioeconomic development of communities, particularly in the developing world, and studies have shown that the digital divide has led to the increasing wealth gap between the rural and urban areas in these countries. Key socioeconomic factors which impact computer usage in rural agricultural and fishing communities in Malaysia are examined in this study. Using the probit model, this study found that access to computers, type of rural community, ethnicity, education, language of communication, gender, social networks (encouragement from peer, family, and teachers), and age are the main factors affecting computer usage. High cost of computers, low computer literacy, and lack of relevance and interest were cited as the main reasons for people not using computers in rural communities. Furthermore, strategies for closing the digital divide in Malaysia are also discussed in this paper.

Keywords: *Computer Usage, Rural Communities, Digital Divide, Malaysia*

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Introduction

The global socioeconomic landscape has undergone major foundational changes, and much of these changes can be attributed to the transformational power of the information and communication technologies (ICTs hereafter). The IT revolution has been a key catalyst in the emergence of the new economy —an economy in which a large proportion of the socioeconomic wealth creation results from the adoption, integration, and diffusion of ICTs. As Kevin Kelly aptly puts it:

> The new economy is about communication, deep and wide. Communication is the foundation of society, of our culture, of our humanity, of our own individual identity, and of all the economic systems. This is why networks are such a big deal. … Communication, and its ally computers, is a special case in economic history. Not because it happens to be the fashionable leading business sector of our day, but because its cultural, technological, and conceptual impacts reverberate at the root of our lives (Kelly, 1998: 5).

The IT revolution has transformed the underlying structure of the global economic systems—traditional factors of production such as land, labor, and capital play an increasingly less significant role in determining competitiveness and wealth of countries in a knowledge-based society. Countries, enterprises, and communities are able to transcend the limitations of the physical space by using electronic media to create value—moving from "the physical place to the cyberspace." Computers also allow various stakeholders to overcome the shortages of human and financial capital by way of outsourcing globally and accessing funds from the global financial market.

ICTs and related technologies have become the fulcrum of socioeconomic development for smaller economies such as Finland, Ireland, and Singapore. These countries have successfully transformed their economies to be knowledge- and innovation-based economies over the last three decades. The role of ICTs in enhancing socioeconomic development is well documented in literature (Brynjolfsson and Hitt, 1995; 2000; Nair et al., 2005; 2008). Pilat and Wolfl (2004) have shown that ICTs have contributed to increased productivity growth in many of the OECD countries as well as the fact that smaller economies such as Finland, Ireland, and Korea experienced large labor productivity growth rates due to ICT utilization.

However, it is questionable whether the benefits of advanced ICTs are also enjoyed among rural communities in many developed countries. To improve the situation, various fiscal and non-fiscal policies have been introduced to encourage computer usage among rural communities. Those policy measures include encouraging computer ownership, providing access to public computer facilities, and introducing computer literacy programs. While these moves have been successful to some extent in increasing computer usage among the rural population in developed countries, they are either not implemented or not effectively deployed in developing countries. As such, the very technology which might facilitate the progression of rural communities of the developing world into a knowledge-based society is the selfsame one which continues to perpetuate the digital, knowledge, and socioeconomic divide between rural and urban areas.

This paper aims to examine the determinants of the digital divide in rural communities of developing countries. A considerable number of studies have examined the key drivers for computer usage in rural communities of developed countries, but only a few have looked at the patterns of rural computer usage in developing countries (Donner, 2008). In addition, current literature on PC adoption in developing countries is often descriptive, thus lacking robust statistical rigor. This study utilizes a robust statistical method (probit model) in an attempt to establish dynamic relationships between socioeconomic and demographic factors and computer adoption, particularly in the context of rural communities of a rapidly growing economy, that of Malaysia.

The paper is organized as follows. A brief review of pertinent literature is provided, followed by ICT development policies in Malaysia. Then the empirical methodology used is described in the next section. Finally, findings are presented, and policy implications discussed.

Review of Literature

Previous studies on technology diffusion theories suggest that socioeconomic and demographic factors such as age, education, income, gender, ethnicity, complexity of technology, and social networks (encouragement from friends and family) are key drivers for the adoption of new technologies (Rogers, 2003). Rogers (2003) also argues that factors such as regions and community are important for providing insight into the social dimensions of adoption patterns.

Several studies have assessed personal computer (PC) ownership and usage as a key determinant in developed countries. Schmitt and Wadsworth (2002) studied the trend of computer ownership in the US and the UK during the

1980s and 1990s. Using the US Consumer Expenditure Survey and the British General Household Survey, the authors found that PC inequality in both countries were related to income, education, age, family type, and race.

Studies among farmers also reveal similar findings. Batte (2005) studied computer usage patterns among a random sample of 2,500 farmers from Ohio, USA. Using the binomial probit model, the study showed that larger farms, farmers with higher education, and younger farmers tend to hold a higher probability of computer adoption. The study also found that leased farmland and farmers who worked away from the farm throughout the year also presented a higher probability of computer adoption. On the other hand, livestock farmers showed a lower probability of computer usage. The usefulness of computers increased for farms with higher gross sales and for farmers who use the technology for record-keeping. This study found that the usefulness of computers declined for older farm workers. Similar findings are recorded by studies that examined the adoption of computers in other agricultural communities (Nuthall, 2004; Putler and Zilberman, 1988; Verstegen and Huirne, 2001).

Although Korea is well known for its advanced ICTs, it cannot avoid the problem of the digital divide between urban and rural areas (Kwon, 2003). To mitigate this problem, some model villages, called "information model villages" or E-villages, were set up by the central and local governments. They are reported in various studies (Choo, 2001a; 2001b; Huh, 2001; 2008; Lee, 2002). Age is a key variable in explaining differences in adoption behavior among rural residents (Huh, 2001). Choo (2001a; 2001b) reports that lack of motivation or demand for using ICTs among the E-village residents is one of the main reasons why those projects are not successful or sustainable. This coincides with Hollifield and Donnermeyer (2003), who argue that creating a demand is the key factor for IT diffusion in rural communities. The top-down approach fails to generate genuine need or demand for ICTs. In response, Huh (2008) examined the business uses of E-villages. The business models performed less than expected, and the low performance is attributed to lack of ICT capability among rural people. Huh (2008) emphasizes the importance of human resource development over the new technology per se. This conclusion is echoed by the criticism of Lee (2002), who claims that more attention (that is, resources) is currently paid to hard infrastructure than to soft infrastructure.

In the Malaysian context, Harris et al. (2001), Bala et al. (2000; 2002; 2003), Songan et al. (2004), and Gnaniah et al. (2006) examined two remote areas, Bario and Long Bedian, within the East Malaysian state of Sarawak. It was found that low computer usage in these two remote communities is attributable to the following factors: lack of access to cost-effective computers and ICT infrastructure, low awareness, weak training in computers, low education level, language barrier, and the ICT contents were not relevant to the needs of the local communities. The study also found that having a local ICT champion in the community can enhance the sustainability of the computer and other ICT initiatives in a rural community.

ICT Development Policies in Malaysia

In the 1980s, the Malaysian Government announced Vision 2020—a plan to transform the country into a knowledge-driven society. The key building block in initiating this transformation is information and communication technologies (ICTs). Consequently, the National Information Technology Council (NITC) was established in 1995 to initiate and execute the National Information Technology Agenda (NITA). NITA was launched in December 1996 under the strict purpose of transforming Malaysia into a developed country. The strategic objectives of NITA are to develop the people, infostructure, and applications needed for a knowledge-based society.

As part of NITA, the Multimedia Super Corridor (MSC) initiative was introduced in 1996. The MSC was not only Malaysia's biggest ICT-based infrastructure initiative developed at a cost of RM76 billion (US$1=RM3.54), it also galvanized the nation into becoming an information-driven society. The MSC was an important catalyst for encouraging leading global ICT enterprises to use Malaysia as a test bed for next-generation multimedia technologies and innovation. The MSC provided a platform for creating an environment similar to that of the Silicon Valley in the US, powering Malaysia's transformation into a global knowledge and innovation hub.

To complement the efforts of the MSC and transform Malaysia into a knowledge-driven society, the government established various fiscal and non-fiscal incentives to encourage computer ownership and computer literacy. The incentive programs introduced were the *One Home One PC*, and *PC Mesti Beli* (*Must Buy Computer*) programs. The latter two programs targeted first-time buyers from low-income groups.

Under these programs, the cost of computers was reduced by abolishing government sales tax on PCs and their components. In addition, the government granted accelerated capital allowance for PCs and ICT equipment, and a tax rebate was given for PC purchases (Ramachandran and Rathina-Paandi, 2003). To reduce the burden of purchasing a computer, people were allowed to use a portion of their Employment Provident Fund (EPF) to buy computers for their home use. However, the latter program was discontinued due to misappropriation of the funds.

The Malaysian government introduced a number of plans to enhance rural computer connectivity. Among them include increased ICT infrastructure spending in rural areas under the 8th Malaysia Plan (2001-2005) (EPU, 2001). This was complemented by the private sector funding under the Universal Service Provision (USP) Fund, which provides ICT connectivity to clinics and other public facilities such as libraries and post offices in rural areas. Under the same plan, investments were increased to connect rural schools to the global information network using Very Small Aperture Terminal (VSAT).

A systematic roll-out plan for broadband across the country was put in place under the 8th Malaysia Plan. However, the broadband roll-out was slow compared to other regional economies, and greater emphasis was given under the 9th Malaysia Plan (2006-2010) for the deployment of broadband across the country. The government envisages that broadband diffusion will increase from 1.9 percent in 2006 to 13 percent by the end of 2010, providing rural communities with greater access to state-of-the-art ICT infrastructure (EPU, 2006).

Over the past five years, the world has witnessed increasing convergence between the internet, mobile phones, and broadcasting. To coordinate the development of ICTs in an increasingly integrated digital economy, the Malaysian government introduced a five-year strategic plan (2006-2010) called MyICMS-886 to coordinate the development of converging technologies. A key milestone under this plan is to increase internet connectivity in rural areas (Kementerian Tenaga, Air dan Komunikasi, 2006).

To increase greater participation of rural communities in the information economy, the Malaysian government introduced a number of strategies to enhance computer literacy. Among them include the Smart School Program, MySchool Net, and Pembestarian Sekolah. These programs employed advanced ICTs in the development and delivery of educational curriculum for schools in Malaysia. A number of community-based telecenter programs were also introduced in rural areas to increase awareness of and training for ICTs in rural communities. Among these programs include the Gerakan Desa Wawasan (Organised Countryside Vision), Medan InfoDesa (Countryside Information Centre), and Pusat Internet Desa (Countryside Internet Centre).

In summary, several policy measures are in place to increase ICT use in rural communities. However, in spite of these initiatives, the level of ICT diffusion in rural Malaysian communities is unclear. In the next section, methodology for assessing the level and key determinants of computer use in rural communities is discussed.

Empirical Methodology

Sample used in this study is drawn from four rural communities in three Malaysian states. These rural communities are comprised of government assisted land schemes (GALS), privately owned plantations (POP), traditional agricultural communities (TAC), and fishing villages (FV). The main livelihood for GALS and POP is oil palm farming, while fruit and vegetable farming is the

Table 1. Summary Statistics of the Sample

	% of rural communities	GALS	POP	TAC	FV
		24	43	11	21
Gender (%)	Male	38	32	35	45
	Female	62	68	65	55
Ethnicity (%)	Malay	100	3	100	23
	Chinese	0	0	0	77
	Indian	0	97	0	0
	Others	0	0	0	0
Age (%)	18 and below	15	16	18	17
	19 to 30	18	27	15	17
	31 to 40	2	11	12	21
	41 to 50	27	19	19	19
	51 to 55	18	13	9	7
	55 and above	20	14	27	19
Household income (%)	No regular income	22	2	42	37
	RM500 or below	3	24	20	8
	RM501 to RM1300	61	56	30	33
	RM1301 to RM2100	6	12	3	9
	RM2101 to RM2900	5	3	3	7
	RM2900 or more	2	2	3	6
Education level (%)	No school	8	24	16	20
	Primary	44	39	31	41
	Junior high	18	23	18	18
	High school	26	13	32	18
	Tertiary	5	2	4	3
Language proficiency (%)	Malay	100	66	100	74
	English	38	26	38	27
	Chinese	0	0	1	79
	Tamil	0	98	0	1

major livelihood for TAC.

Respondents were selected based on random sampling in areas with household lists. For those without a household list, maps were used to locate respondents' houses. For areas without maps, village headmen assisted in showing the boundary of their villages.

A questionaire-based survey method was used to capture the computer usage patterns among these four rural communities. The questionaire consists of the following sections: household information (number of family members, income level, and ICT information available in the home), demographics, and computer usage patterns.

The survey was administered between July and September 2007. A total of 552 households were visited, and information from 1,020 respondents were obtained. The response rate for the survey was approximately 80 percent. A summary statistics for this sample group is provided in Table 1.

The Regression Model

The primary objective of this paper is to empirically examine the key factors contributing to the usage of computers in rural Malaysian communities. Therefore, let us assign $Computer_i$ to be a dichotomous response variable for person i and define it as follows:

$$Computer_i = \begin{cases} 1 \text{ if use computer} \\ 0 \text{ otherwise} \end{cases} .$$

Then, the probability of computer use for person i can be defined by the following probit model:

$$\text{Prob}\left(Computer_i = 1\right) = \Phi \begin{pmatrix} \beta_0 + \beta_1 Access_i + \beta_2 GALS_i + \beta_3 POP_i \\ +\beta_4 TAC_i + \beta_5 Malay_i + \beta_6 Chinese_i \\ +\beta_7 JHS_i + \beta_8 HS_i + \beta_9 Tertiary \\ +\beta_{10} Working_i + \beta_{11} Student_i + \beta_{12} LanEnglish_i \\ +\beta_{13} LanMalay_i + \beta_{14} LanChinese_i + \beta_{15} LanTamil_i \\ +\beta_{16} Married_i + \beta_{17} Male_i + \beta_{18} Income1_i \\ +\beta_{19} Income2_i + \beta_{20} Income3_i + \beta_{21} Income4_i \\ +\beta_{22} Encourage_i + \beta_{23} Age_i \end{pmatrix} + \varepsilon_i \quad (1)$$

where $\Phi(\cdot)$ is called the normal cumulative distribution function. Predictor variables are defined as follows:

$$Access_i = \begin{cases} 1 \text{ if have computer access} \\ 0 \text{ otherwise} \end{cases}$$

The types of rural communities are defined as:

$$GALS_i = \begin{cases} 1 \text{ if Government Assisted Plantations} \\ 0 \text{ otherwise} \end{cases}$$

$$POP_i = \begin{cases} 1 \text{ if Private Operated Plantations} \\ 0 \text{ otherwise} \end{cases}$$

$$TAC_i = \begin{cases} 1 \text{ if Traditional Agriculture Communities} \\ 0 \text{ otherwise} \end{cases}$$

The ethnicity of respondents is as follows:

$$Malay_i = \begin{cases} 1 \text{ if respondent's ethnicity is Malay} \\ 0 \text{ otherwise} \end{cases}$$

$$Chinese_i = \begin{cases} 1 \text{ if respondent's ethnicity is Chinese} \\ 0 \text{ otherwise} \end{cases}$$

The highest education level for the respondents is as follows:

$$JHS_i = \begin{cases} 1 \text{ if Junior High School} \\ 0 \text{ otherwise} \end{cases}$$

$$HS_i = \begin{cases} 1 \text{ if High School} \\ 0 \text{ otherwise} \end{cases}$$

$$Tertiary_i = \begin{cases} 1 \text{ if Tertirary Studies} \\ 0 \text{ otherwise} \end{cases}$$

The occupation of the respondents is as follows:

$$Employed_i = \begin{cases} 1 \text{ if currently employed} \\ 0 \text{ otherwise} \end{cases} \text{ and } Student_i = \begin{cases} 1 \text{ if student} \\ 0 \text{ otherwise} \end{cases}$$

The main language used by the respondents for communication is as follows:

$$LanEnglish_i = \begin{cases} 1 \text{ if have English language proficiency} \\ 0 \text{ otherwise} \end{cases},$$

$$LanMalay_i = \begin{cases} 1 \text{ if have Malay language proficiency} \\ 0 \text{ otherwise} \end{cases},$$

$$LanChinese_i = \begin{cases} 1 \text{ if have Chinese language proficiency} \\ 0 \text{ otherwise} \end{cases}$$

$$LanTamil_i = \begin{cases} 1 \text{ if have Tamil language proficiency} \\ 0 \text{ otherwise} \end{cases}$$

The marital status and gender of the respondents are as follows, respectively:

$$Married_i = \begin{cases} 1 \text{ if Married} \\ 0 \text{ otherwise} \end{cases} \text{ and } Male_i = \begin{cases} 1 \text{ if Male} \\ 0 \text{ otherwise} \end{cases}$$

The income level (reported in Malaysian Ringgit) of the respondents are as follows:

$$Income1_i = \begin{cases} 1 \text{ if RM510} \leq \text{income } \leq 1300 \\ 0 \text{ otherwise} \end{cases},$$

$$Income2_i = \begin{cases} 1 \text{ if RM1301} \leq \text{income } \leq 2100 \\ 0 \text{ otherwise} \end{cases},$$

$$Income3_i = \begin{cases} 1 \text{ if RM2101} \leq \text{income } \leq 2900 \\ 0 \text{ otherwise} \end{cases} \text{ and}$$

$$Income4_i = \begin{cases} 1 \text{ if income } \geq 2901 \\ 0 \text{ otherwise} \end{cases}.$$

Encouragement from family, friends, and teachers (social network variable) is defined as:

$$Encourage_i = \begin{cases} 1 \text{ if was encouraged by family, friends or teachers} \\ 0 \text{ otherwise} \end{cases}$$

The age of the ith respondent is denoted as Age_i. The residuals ε_i are assumed to follow normal distribution with mean 0 and variance-covariance matrix Ω. The parameters of interest are denoted as βs.

Since there are strong correlations among types of rural community, ethnicity, and local languages spoken, estimating (1) will result in a serious multicollinearity problem with incorrect statistical inferences. To overcome the multicollinearity problem, three separate models were estimated for community type, ethnicity, and local languages. These models are given below.

MODEL 1: (Model of Types of Rural Communities)

$$\text{Prob}\ (Computer_i = 1) = \Phi \begin{pmatrix} \beta_0 + \beta_1 Access_i + \beta_2 GALS_i + \beta_3 POP_i + \beta_4 TAC_i \\ +\beta_5 JHS_i + \beta_6 HS_i + \beta_7 Working_i + \beta_8 Student_i \\ +\beta_9 LanEnglish_i + \beta_{10} Married_i + \beta_{11} Male_i \\ +\beta_{12} Income1_i + \beta_{13} Income2_i + \beta_{14} Income3_i \\ +\beta_{15} Income4_i + \beta_{16} Encourage_i + \beta_{17} Age_i \end{pmatrix} + \varepsilon_i \quad (2)$$

MODEL 2: (Ethnicity Model)

$$\text{Prob}\ (Computer_i = 1) = \Phi \begin{pmatrix} \beta_0 + \beta_1 Access_i + \beta_2 Malay_i + \beta_3 Chinese_i \\ +\beta_4 JHS_i + \beta_5 HS_i + \beta_6 Working_i + \beta_7 Student_i \\ +\beta_8 LanEnglish_i + \beta_9 Married_i + \beta_{10} Male_i \\ +\beta_{11} Income1_i + \beta_{12} Income2_i + \beta_{13} Income3_i \\ +\beta_{14} Income4_i + \beta_{15} Encourage_i + \beta_{16} Age_i \end{pmatrix} + \varepsilon_i \quad (3)$$

MODEL 3: (Model of Local Languages)

$$\text{Prob}\ \left(Computer_i = 1\right) = f\begin{pmatrix} \beta_0 + \beta_1 Access_i + \beta_2 JHS_i + \beta_3 HS_i \\ +\beta_4 Working_i + \beta_5 Student_i + \beta_6 LanEnglish_i \\ +\beta_7 LanMalay_i + \beta_8 LanChinese_i \\ +\beta_9 LanTamil_i + \beta_{10} Married_i + \beta_{11} Male_i \\ +\beta_{12} Income1_i + \beta_{13} Income2_i + \beta_{14} Income3_i \\ +\beta_{15} Income4_i + \beta_{16} Encourage_i + \beta_{17} Age_i \end{pmatrix} + \varepsilon_i \quad (4)$$

Model 1, Model 2, and Model 3 are estimated using the maximum likelihood estimator (MLE) method and using the Huber-White standard for correcting model misspecification in the distribution of computer usage function (Greene, 2008).

The goodness of fit of the estimated models was measured using the McFadden-R^2 (higher value will indicate better model fit). The errors in the predictions for the sample were computed, and percentage of correct prediction for all three models reported. The Hosmer-Lemeshow Test (HLT; Hosmer and Lemeshow, 1989) was used to test the correct specification of the models.

The Likelihood-Ratio Test (LRT) is used to conduct the pairwise comparison between GALS and POP (denoted as GALS-POP), where the following hypothesis is tested:

$$\begin{aligned} H_0 &: \beta_2 = \beta_3 \\ H_A &: \beta_2 \neq \beta_3 \end{aligned} , \qquad (5)$$

and the LRT statistic is as follows:

$$LR = 2\left(l_u - l_r\right) \qquad (6)$$

where l_u and l_r are the log-likelihood of the unrestricted model (under H_A in (5)) and restricted model (under H_0 in (5)), respectively. The LRT statistic follows a Chi-square distribution with degrees of freedom as the number of restriction under the null hypothesis given in (5). The pairwise test was also conducted for types of rural communities, ethnicity, education level, employment status, and income level.

Empirical Findings

As shown in Figure 1, only 22% of the rural population uses computers. The percentage of computer use varies among the four rural communities, with GALS having the highest percentage of computer users (37%). This is followed by TAC and FV with 34% and 22%, respectively. POP has the lowest computer usage with only 12%.

Factors that impact computer use are studied in Model 1, Model 2, and Model 3, and results from these models are reported in Table 2. The McFadden-R^2 for the three models was found to be 0.6419, 0.6339, and 0.6403, respectively; the percentage of correct predictions by these models was 91.57%, 91.76%, and 91.76%, respectively. The McFadden-R^2 and the percentage of correct predictions indicate that the estimate has a reasonably good model fit. The p-values of the HLT statistic (in Table 3) for the three models were 0.9195, 0.9326, and 0.9833, indicating the null hypothesis that the three models are correctly specified is not rejected.

In all three models, the coefficient for Access is positive and statistically significant at 1%, which implies that access to computers in rural communities is important in encouraging computer use among rural Malaysian communities. The coefficients for GALS and TAC were found to be positive, but not statistically significant at 10%. This implies that the probability of computer use in GALS and TAC is higher than FV, but the differences among them are not statistically significant. On the other hand, the coefficient for POP was found to be negative

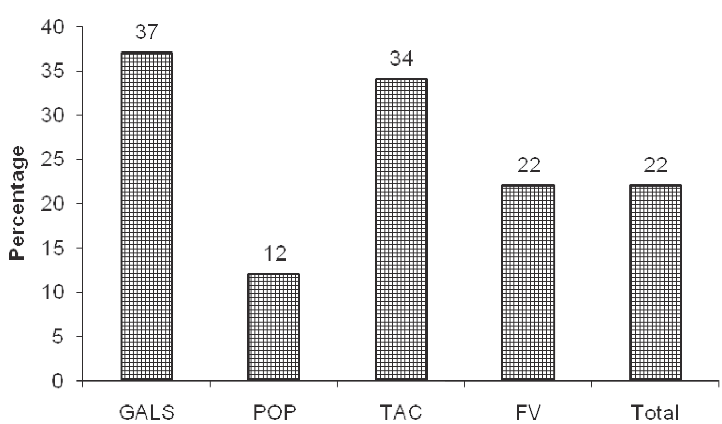

Figure 1. Current PC Users.

Table 2. Estimated Regression Models for Computer Usage

	Model 1		Model 2		Model 3	
	Coefficient	Prob.	Coefficient	Prob.	Coefficient	Prob.
Constant	-1.206746	0.0013*	-1.834360	0.0000*	-1.227087	0.0081*
Access	1.344434	0.0000*	1.342522	0.0000*	1.337595	0.0000*
GALS	0.298864	0.1685				
POP	-0.540891	0.0106**				
TAC	0.371203	0.1363				
Malay			0.772180	0.0000*		
Chinese			0.634454	0.0051*		
JHS	0.190328	0.2992	0.204599	0.2630	0.177324	0.3360
HS	0.714339	0.0002*	0.742463	0.0001*	0.724972	0.0001*
Tertiary	1.762928	0.0044*	1.766841	0.0035*	1.742714	0.0039*
Working	0.174020	0.3522	0.141529	0.4530	0.131188	0.4859
Student	0.212813	0.3872	0.234275	0.3409	0.202635	0.4151
LanEnglish	0.832479	0.0000*	0.836958	0.0000*	0.835026	0.0000*
LanMalay					0.216467	0.4847
LanChinese					-0.129948	0.5392
LanTamil					-0.757686	0.0001*
Married	0.102658	0.6024	0.088963	0.6483	0.087629	0.6535
Male	0.664079	0.0000*	0.635871	0.0000*	0.645590	0.0000*
Income1	-0.022522	0.8942	-0.029273	0.8607	-0.023546	0.8884
Income2	-0.015158	0.9495	-0.012799	0.9570	-0.030229	0.8990
Income3	-0.297258	0.4798	-0.312633	0.4642	-0.297159	0.4912
Income4	-0.235295	0.4324	-0.248203	0.3990	-0.260388	0.3769
Encourage	1.474151	0.0000*	1.508792	0.0000*	1.499105	0.0000*
Age	-0.049729	0.0000*	-0.046917	0.0000*	-0.047397	0.0000*
McFadden R^2	0.6419		0.6399		0.6403	
% Correct	91.57		91.76		91.76	
H-L Statistic	3.2242		3.0283		1.9226	
H-L Probability	0.9195		0.9326		0.9833	

Note: *, **, and *** denote significance levels of 1%, 5%, and 10%, respectively.

and statistically significant at 5%, indicating that the probability of computer use in POP is significantly lower than FV. Pairwise comparisons among the coefficients for GALS, POP, and TAC show that the test is statistically significant only for GALS-POP and POP-TAC at 1%. This implies that POP has a lower probability of computer use than GALS and TAC.

The impact of ethnicity on the probability of computer use was assessed, and this model shows that the coefficients for Malay and Chinese are positive and statistically significant at 1%. These results indicate that rural communities of Malay and Chinese ethnic origins have significantly higher probability of computer use than Indians. The pairwise comparison between the Malays and Chinese shows that the p-value for the LRT test statistic is 0.5218. Thus, the probability of computer use between rural Malay and Chinese ethnic communities is the same.

On education, all three models show that the coefficient for *JHS* is positive and not statistically significant at 10%, thus indicating that the probability of computer use between rural population with education level of *JHS* and of lower than *JHS* is the same. The coefficients for *HS* and *Tertiary*, on the other hand, are positive and statistically significant at 1%. This implies that rural communities with high school and tertiary education have higher probability of computer use than rural communities with education below *JHS* level.

Pairwise comparisons among *JHS-HS*, *JHS-Tertiary*, and *HS-Tertiary* in Table 3 show that the p-values were below 10% in significance level. These results indicate that there is a significant difference in the probability of computer use among different education levels, those with tertiary education having the highest probability of computer use, followed by people with high school and junior high school qualifications. The empirical results suggest that higher educational attainment indicates a higher probability of computer usage.

The estimated coefficients for working people (Employed) and students (Student) are positive but statistically not significant at 10% for all three models. This implies that computer usage among working people and students are higher than those who are not working. However, the differences in computer usage between these two groups of people are not dissimilar. The pairwise comparison between working people and the student population also reveals that the patterns of computer usage between working people and the student population are similar (Table 3).

With regards to the communication language in these communities, the estimated coefficients for people who can communicate in English (*LanEnglish*) for all three models are found to be positive and statistically significant at 1%. This implies that people who are able to communicate in English have a higher probability of using computers than those who are unable to communicate in English. Model 3 shows that the coefficients for *LanMalay* and *LanChinese* are positive and negative, respectively. However, the impact of *LanMalay* and *LanChinese* on the probability of computer use is not statistically significant at 10%. This implies that Malay and Chinese languages are not good predictors for the probability of computer use. The impact of Tamil language on the probability of computer use was also assessed by Model 3, and the coefficient for

Table 3. Pairwise Hypothesis Test between the Coefficients Using the Likelihood Ratio Statistic

	Model 1		Model 2		Model 3	
	Community		Ethnicity		Language	
	Chi-sq	Prob.	Chi-sq	Prob.	Chi-sq	Prob.
GALS-POP	15.84433	0.0001*				
GALS-TAC	0.089988	0.7642				
POP-TAC	14.15122	0.0002*				
Malay-Chinese			0.410264	0.5218		
JHS-HS	7.433792	0.0064*	7.784580	0.0053*	8.148012	0.0043*
JHS-Tertiary	6.513433	0.0107**	6.722604	0.0095*	6.801519	0.0091*
HS-Tertiary	2.881664	0.0896***	2.864872	0.0905***	2.855872	0.0910***
Working-Student	0.021368	0.8838	0.119631	0.7294	0.069322	0.7923
LanEnglish-LanMalay					2.690871	0.1009
LanEnglish-LanChinese					13.63974	0.0002*
LanEnglish LanTamil					35.17656	0.0000*
LanMalay-LanChinese					0.842698	0.3586
LanMalay-LanTamil					9.547127	0.0020*
LanChinese-LanTamil					7.374256	0.0066*
Income1-Income2	0.001071	0.9739	0.005424	0.9413	0.000898	0.9761
Income1-Income3	0.452102	0.5013	0.467203	0.4943	0.432090	0.5110
Income1-Income4	0.589598	0.4426	0.637433	0.4246	0.749952	0.3865
Income2-Income3	0.395539	0.5294	0.436822	0.5087	0.342851	0.5582
Income2-Income4	0.445821	0.5043	0.513007	0.4738	0.495413	0.4815
Income3-Income4	0.016068	0.8991	0.017191	0.8957	0.005576	0.9405

Note: *, **, and *** denote significance levels of 1%, 5%, and 10%, respectively.

LanTamil is negative and statistically significant at 1%. This implies that those who communicate in the Tamil language have significantly lower probability of using computers.

Pairwise comparisons among the languages show that *LanEnglish-LanChinese*, *LanEnglish-LanTamil*, *LanMalay-LanTamil*, and *LanChinese-LanTamil* are statistically significant at 1%. The results indicate that people who speak Tamil and Chinese have a significantly lower probability of using computers than people who speak English. The pairwise test also shows that people who speak Tamil have significantly lower probability of using computers than people who speak Malay or Chinese.

The coefficient for marital status (*Married*) is positive but not statistically significant at 10% in all three models. This implies that married people have a higher probability of computer usage than non-married people. However, the differences in computer usage between these two categories of people are not statistically significant.

Analysis by income level (*Income1*, *Income2*, *Income3*, and *Income4*) in all the three models shows that the differences are not statistically significant at 10%. Pairwise comparisons among the income groups show that the income groups' computer usage patterns are similar (Table 3). This implies that income level is not a good predictor of computer usage.

The coefficients for gender (*Male*) and encouragement (*Encourage*) are positive and statistically significant at 1% for all three models. This implies that gender and encouragement (by family, friends, and teachers) have a positive impact on the probability of computer use.

The coefficient for *Age* is negative and statistically significant at 1% in the three models, indicating that younger people have a higher probability of using computers than older people.

In the survey questionnaire, respondents who did not use a computer were asked about their reasons for not using a computer. Results from these respondents are summarized in Figure 2. The top three reasons for not using computers are as follows: "don't know how to use computers" (42%), "unable to afford computers" (40%), and "not interested in using computers" (9%).

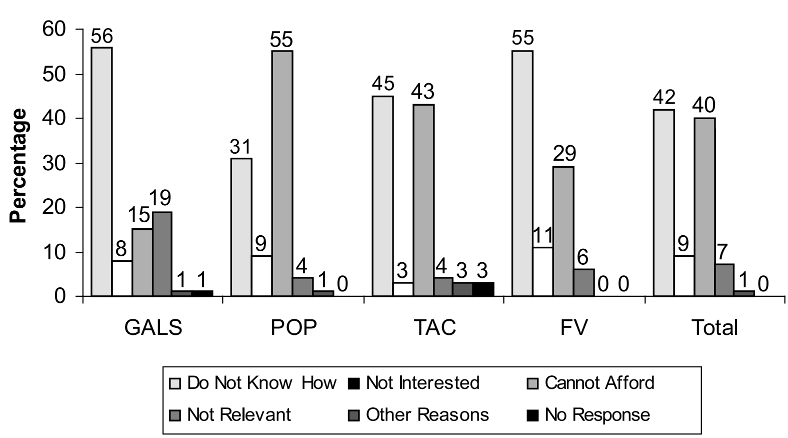

Figure 2. Reasons for Not Using PC.

Discussion and Policy Implications

Empirical analysis of this study suggests that access to affordable computers, type of rural communities, ethnicity, education level, language proficiency, gender, age, and encouragement (by peers, family, and teachers) are important determinants of computer usage within the rural communities in Malaysia.

In the rural Malaysian communities, income level tends to be low, and thus, cost of computers and other ICT facilities are beyond the means of a large proportion of the people living there. The low level of computer usage in these communities is further compounded by low computer literacy and the inability to contextualize the benefits that computers can offer towards improving their quality of life.

As previously mentioned, computerization has become a crucial factor in assisting rural and remote communities transform themselves into knowledge-based economy. To help these disadvantaged communities transform themselves, a multi-strategy approach should be implemented to encourage greater ownership of computers. Effort should be expended in rural areas to increase awareness of the one-home-one-computer scheme introduced by the Malay government.

The existing program for establishing a publicly funded tele-center in each rural district should be complemented by a "PC recycling" program. Every year, thousands of computers are discarded by the government and the industry. Many of these unused computers end up in waste dump sites, which not only increase the burden of waste disposal, but also contaminate the environment. These computers can be refurbished, recycled, and sold at a nominal price for rural home use. In addition, they can also be distributed to schools and public computer facilities in rural areas, thereby greatly reducing the Malay government's financial burden in providing computers to schools nationwide.

The PC recycling program has been used in several developed countries in an effort to connect schools and disadvantaged communities to the information economy. One such initiative is the Dumfries and Galloway School Project (supported by the Scottish Schools Board) which aims to provide schools with access to computers (Malakooty, 2007).[1]

The PC recycling program is also an important source of training and employment. It can be used to train rural people to assemble and refurbish

[1] A description of similar programs in the United Kingdom is available at the following website: http://www.dti.gov.uk/support/comp.htm.

computers, thus providing them with skills which can readily be transposed and transplanted to a knowledge-based economy. Technical colleges, polytechnics, and learning centers should be established to teach rural people about both hardware and software development in computers. For people in rural areas, such skills would equip them to assemble and upgrade old computers, making it possible to re-employ these computers in the rural Malaysian communities as well as sell them on the secondhand PC market (including exporting them to other under-developed and developing countries). Proceeds from these recycled computers can be used to fund other ICT infrastructures and skills development programs.

Empirical analysis in the section above highlights the fact that education, especially computer literacy, plays a crucial role in enhancing computer usage among rural communities. Raising the level of computer literacy among the rural population should remain an important priority for the government, industry, and other stakeholders. Under the 9th Malaysia Plan, a number of initiatives such as the Smart School and public tele-center programs have been introduced to improve the situation of low ICT literacy. Implementation of these ICT programs should be sped up and managed effectively.

Such existing programs can be complemented further by introducing incentives for teachers in rural areas to acquire ICT skills through training, and allowing them to supplement their incomes by permitting them to seek part-time employment in the public sector or public tele-centers in rural areas. This would yield several spill-over benefits: (1) teachers in rural areas can increase their income; (2) shortage of ICT personnel in rural areas would be reduced; (3) government's financial burden in providing ICT training for rural communities would be reduced; and (4) ICT teachers would be able to incorporate their industry knowledge in classroom teaching.

One of the major factors hindering the use of computers in rural areas is the discrepancy between the language required for computer use and the primary languages spoken in the four rural communities of Malaysia. Only 38% in GALS can communicate in English, 26% in POP, 38% in TAC, and 27% in FV. In GALS and TAC, Malay is the most widely spoken language. In POP and FV, Tamil and Chinese are the main languages of communication, respectively. The problem is compounded by the lack of ICT content that meets the needs of the rural agricultural and fishing communities. To overcome these problems, the Malaysian government should put the following incentive schemes in place to encourage the development and use of ICT content in local languages:

- tax incentives for firms that develop user-friendly content in local languages and multimedia technologies, such as the development of voice-recognition tools using local languages (with software requiring little use of keyboards);
- fiscal incentives (grants) and non-fiscal incentives (patenting and commercialization facilities and support systems) for teachers and the academia to develop ICT and multimedia technologies that are relevant to the rural agricultural and fishing communities;
- tax incentives, subsidies, and research grants that encourage industries to develop new user-friendly ICT hardware and software for the rural population; and
- subsidies and tax incentives for small enterprises in the rural agricultural and fishing communities to adopt new ICT hardware, software, and new business models which use technology.

This research has revealed that women, Indians, older citizens, and people from POP use computers less than other groups. Greater effort should be made to encourage computer usage among these segments of the rural population. Community champions should be identified and given a greater role in developing, mobilizing, and disseminating computer awareness as well as other ICT programs for their respective communities. Social networks that serve women, elderly people, and people in POP should be promoted to ensure that these networks become the primary source of encouraging computer usage among women and the elderly in rural areas.

Concluding Remarks

The Government of Malaysia has been pro-active in trying to close the digital divide over the past decade or so. A number of plans and programs have been proposed to provide rural communities with computer connectivity. However, empirical analysis from this survey shows the percentage of people using computers is only 22%. In some communities like POP, computer use is just around 12%.

Empirical analysis of this paper found that factors affecting computer use in rural areas of Malaysia are similar to those found in other countries or areas. These factors are access to affordable computers, type of rural community, ethnicity, education level, language of communication, gender, age, and encouragement from friends, family, and teachers.

While it is important to understand these factors that affect computer usage, it is also critical to assess whether computer use is relevant to the needs of rural community members in improving their quality of life. This type of assessment will provide a better insight into appropriate public policies and programs that will encourage the use of computers among rural communities. Future research should therefore be directed at studying the type of computer infrastructure and applications that are relevant to rural communities with low education level and English language proficiency. Information obtained from these studies can be used by public policy organizations and non-governmental organizations to upgrade their services in rural areas so that people can benefit positively from the use of computers and leapfrog into a knowledge-based economy.

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MAHENDHIRAN NAIR is Professor of Econometrics and Deputy Head of School (Research) at the School of Business, Monash University Sunway Campus, Malaysia. Professor Nair currently heads a research team there that studies the impact of ICT and innovation on competitiveness and sustainable development of nations, enterprises, and rural communities. His research interests and expertise are in the areas of information modelling, innovation ecosystems and sustainable socioeconomic development.

Address: School of Business, Monash University Sunway Campus, Jalan Lagoon Selatan, Bandar Sunway, 46150, Selangor Darul Ehsan, Malaysia

[*Email*: mahendhiran.nair@buseco.monash.edu.my]

GIL-SOO HAN is Associate Professor in the School of English, Communications, and Performance Studies at Monash University, Australia. He has researched and published works in religion, ethnicity, health & illness, and information, communication, and technologies. Han's research is centred on the intersections between individual aspirations and institutional changes in the context of socio-economic and global change.
Address: School of English, Communications, and Performance Studies, Monash University, Victoria 3800, Australia [*Email*: Gil-Soo.Han@monash.edu]

HEEJIN LEE is Professor and Associate Dean at the Graduate School of International Studies, and Director of the Centre for Australian Studies, Yonsei University, Korea. His research interest includes IT/IS in developing countries with current focus on North Korea and international standards setting in China and Korea. He has edited special journal issues such as *The Information Society and Journal of Information Technology*. He is also currently an associate editor of *Journal of Research and Practice in Information Technology*.
Address: Graduate School of International Studies, Yonsei University, 262 Seongsanno, Seodaemun-gu, Seoul 120-749, Korea [*Email*: heejinmelb@yonsei.ac.kr]

PATRICIA GOON is a lecturer at the School of Arts and Social Sciences, Monash University Sunway Campus, Malaysia. Her research interests are in the areas of post-colonial subjectivity, popular culture studies, science fiction, and cyber theory.
Address: School of Business, Monash University Sunway Campus, Jalan Lagoon Selatan, Bandar Sunway, 46150, Selangor Darul Ehsan, Malaysia
[*Email*: patricia.goon@sass.monash.edu.my]

RAMLAH MUDA is a research assistant at the School of Business, Monash University Sunway Campus, Malaysia.
Address: School of Business, Monash University Sunway Campus, Jalan Lagoon Selatan, Bandar Sunway, 46150, Selangor Darul Ehsan, Malaysia
[*Email*: ramlah.muda@buseco.monash.edu.my]