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ABSTRACT

The globalization of the world economy presents opportunities and challenges for developing regions such as Sub-Saharan Africa as they seek to improve their levels of development. The fact that information and communication technologies (ICTs) are not artifacts also presents some hurdles, as they normally need modifications to fit local contexts. This requires that processes that affect interactions between global, regional, and local levels need to be understood. It appears reasonable to conjecture that understanding the roles or effects of socio-economic and cultural factors (amongst others) would lead to more effective ICT policies for sustainable development at regional and local levels. This would ultimately benefit both developing as well as developed countries, as it would enhance global commerce and human development across the world's least developed countries, which make up some 75% of the world's population, but consume only 16% of world's products. We start our discussions by presenting a brief survey of some related streams of research on development. We present and argument against the suitability of classic theories such as Rostow's Stages-of-Growth. We propose an integration of Sen's Capability Approach and Cognitive Constructivist theories that recognize the dialectics between localism and globalism. In order to capture some realities in developing countries, we present a modified version of the "perceived user resource model" which came from the original Technology Acceptance Model (TAM) literature; we also borrow from research espoused in Information Technology vis-à-vis socio-economic development. The proposed model is validated by analyzing survey data gathered in two Sub-Saharan African countries; although no claim is made as to its generalizability. Some diagnostics and prescriptions for how to effect a sustainable technology adoption and development across the region are then presented.

Key Words: Stages-of-Growth model; Sen's Capability Approach; Accessibility; Globalization; Localization; Sub-Saharan Africa; Socio-economic Development; Perceived User Resource Model; Modified TAM.

INTRODUCTION AND THEORETICAL DEVELOPMENT

The task of improving the level of development across the world's least developed countries to a level comparable to those prevalent in developed countries is rather complex. Some of the vexing difficulties could be attributed to various issues, which include socio-economic, geo-political, cultural, and infrastructural factors. Prescribing a universal method that would ensure sustainable development is not an easy proposition, given the enormous disparities that exist even within developing regions in terms of educational levels, incomes, access to ICTs, healthcare, culture, urban versus rural dwellers, etc.

From the foregoing, the notions espoused in Rostow's Stages-of-Growth theory may not fit present-day realities of developing countries. The Stages-of-Growth theory presented by Rostow shortly after World War II contends that "the process of development is a series of economic growth through which all countries must pass" (Rostow, 1962; Gottheil, 2002). The theory consists of a set of five linear stages through which all countries must pass to attain an optimal level of development. The assumption is that a given country would be at one of the five linear stages at any given time, and would progress through the five stages until it reaches the plateau (the fifth level). It should be noted that Rostow's model was based on western cultures that were largely agrarian at the time, and may not be applicable to present-day's under-developed

countries that are characterized by enormous disparities, where enclaves of affluence and high technology co-exist with slum dwellers in the same country or even city. We believe that merely focusing on why under-developed countries remain so is not as useful as offering alternative human development perspectives with concrete ideas on how a country should initiate and sustain development that would benefit the masses (Musa, 2006).

Sen's Capability Approach offers one such alternative human development perspective. It introduces the notion of human agency and widens the scope of development discussions to include non-economic resources. In this approach, Sen identifies what he classified as "functionings" of individuals and the examination of their well-being by evaluating either the individuals' set of "functionings", which he called "capabilities". According to Sen: "*A functioning is an achievement of a person: what he or she manages to do or to be. It reflects a part of the "state" of the person. It has to be distinguished from the commodities which are used to achieve those functionings. For example, bicycling has to be distinguished from possessing a bike. It has to be distinguished also from the happiness generated by the functioning, since cycling around must not be identified with the pleasure obtained from that act. A functioning is thus different both from (1) having goods (and the corresponding characteristics), to which it is posterior, and (2) having utility (in the form of happiness resulting from that functioning), to which it is, in an important way, prior"* (Sen, 1983).

The above illustration can be applied to developing countries in the areas of technology, food, healthcare, education, etc. as these are all relevant to development. Although access is important to ultimate use, it does not guarantee use, development of application in the local contexts, or ultimate happiness from use. For example, having access to food would not make someone that has some form of eating disorder to achieve a healthy state of being (World bank, 1993). Similarly, while access to ICTs is a prerequisite to its use, individual differences in time and space, as well as capabilities and choice may also play a role on the use, value and application of the ICTs (Alampay, et al., 2003). Understanding how various factors impact ultimate application of technology for development in global, regional, and local contexts would lead to the formulation of appropriate policies for developing countries (Nhampossa, 2004). Some researchers have voiced the concern that local diversity and autonomy of regions must play strategic roles in development policies (Agnew, 2000; Roca, 2000; Massey and Jess, 1995). These researchers point to the needs for understanding the dialectics between the global and the local in order to effect sustainable and contextually meaningful adoption and diffusion of technology in developing countries (Roca, 2000).

It is the need to understand the relevant of socio-economic and cultural issues in developing countries in information technology for development that provided the initial motivation for this paper. We point out that just as Rostow's Stages-of-Growth (and other theories) was based on experiences of western cultures, the original technology acceptance model was developed based on settings in developed countries such as the U.S. We argue that TAM needs to be modified to reflect the realities that are prevalent in developing regions such as Sub-Saharan Africa.

DEVELOPING COUNTRIES AND THEORETICAL DEVELOPMENTS

While there has been considerable research on innovation adoption and diffusion especially in the rapid growth area of Information Technology, most has focused on developed countries (Mathieson et al., 2001; Straub, 1994; Gallivan, 2001). In spite of the fact developing countries make up 75% of the world's population, mainstream Information Systems research with a focus on developing countries and the sub-Saharan African region is very rare (Sahay and Avgerou, 2002, p.74). With the right focus, strategy, and time, the developing regions of continent could some day be a viable producer and consumer of technology. The world cannot afford to write off the 690 million people in Sub-Saharan Africa make up 88% of the world's least developed countries (Morales-Gomez and Melesse, 1998, p.7).

Need to Modify TAM Model for Developing Countries

Technology Acceptance model was developed under the premise that technology is readily available and the onus of accepting or rejecting it resides with the end user. However, this assumption falls short of realities in developing countries such as Sub-Saharan Africa. The masses of Sub-Saharan Africa lag behind the rest of the world in basic socio-economic factors such as income, education, health, productivity, etc., all of which are pertinent to the day-to-day use of modern technologies (Mbarika, Musa, Byrd, and McMullen, 2002).

To the vast majority of potential users in developing countries, adoption is not about choice, since universal access to technology is not available. It is noteworthy here that much of the IT infrastructure in sub-Saharan Africa is concentrated largely in a few metropolitan areas that account for less than 30% of the region's population. Furthermore, only relatively few of those living in the metropolitan areas have access to information and communications technologies (ICTs). Given this

scenario, it is no wonder that when it comes to Sub-Saharan Africa, ICTs are considered luxury items affordable only by the "bourgeoisie" (Ansah, 1985; Mbarika et al., 2002).
We posit that access and exposure to basic forms of technology over a period of time allows for a much easier progression to, and acceptance of, modern types of technologies. This is because technologies are not artifacts that could be adopted immediately by all of societies regardless of historical, cultural, or socio-economic conditions. The evidence of failure and waste which often results from sudden massive transfer of ICTs to developing countries with hopes of igniting the engines of social development must be appreciated (Odedra-Straub, 1996; Morales-Gómez and Melesse, 1998; Madon, 1999, Sein and Ahmad, 2001; Sein and Harindranath, 2004). For most people in Sub-Saharan Africa and other developing countries, access to and familiarity with even the most basic forms of technologies remains a dream. For example, out of the 690 million people in the region, a paltry 150,000 (or 2 out of 10,000) people had Internet dialup access in the year 2001 (Jensen, 2001). The reported significant increase in mobile phones over the past few years does not change the fundamental problems that persist (Musa, et al., 2005). The masses in developing countries yearn for basic infrastructure for socio-economic developments, from which access and exposure to more modern technologies could follow.

We do not claim that there is a complete access to technology for those who live in developed countries such as the United States. However, it is hard to deny the relative ease of outright ownership or access to ICTs through various means such as public libraries, schools, hotels, recreation centers, work places, by those who live in developed countries. The level of socio-economic development and sophistication in the use or application of the ICTs is also much higher in developed countries because they have had years of exposure to technology, going back to the most basic forms. The situation that prevails in regions such as Sub-Saharan Africa that have battled with long histories of deprivation in the most basic amenities such as electricity and potable drinking water is understandably different.

From the foregoing, it would seem reasonable that we should not simply export the original technology adoption or diffusion models or experiences from the developed nations of the world to apply to Sub-Saharan Africa without accounting for various local circumstances. Our study builds on the works of other researchers that have made notable contributions to the field of information technology adoption and socio-economic development (e.g., Davis, et al., 1989; Mathieson, et al., 2001; de Vreede et al., 1999; Malhotra and Galletta, 1999; Madon, 2000). We believe that the new TAM model would be more relevant to less developed regions such as Sub-Saharan Africa where universal access to ICTs and sustainable economic development remains illusive. We add to the discussion by gathering data from Sub-Saharan Africa to shed some light on the dynamics and precursors relevant to technology adoption in the region. We also present how accessibility and exposure over time plays a role in technology adoption.

Offering an appropriate extension of the TAM model to account for cases where potential users face inadequate accessibility and exposure due to non-availability of technology resources or other reasons is one of the contributions of this paper. Another contribution is that we explore the factors that contribute to the perpetual inadequacy of modern technologies in developing countries, particularly Sub-Saharan Africa (by merging TAM with socio-economic/human development literature). A third contribution relates to policy prescriptions of how best to effect a systematic development of infrastructure that leads to sustainable socio-economic development and requisite technologies that support the needs of developing regions. The model we present shows interactions between socio-economic development and accessibility to technology in least developed countries. We also point out the effects of what we call negative and positive impact factors to development.

Genealogy and Extension of Technology Acceptance Model

Researchers have studied TAM from various perspectives. One perspective looks at the influence of perceived user resources (Fishbein and Ajzen, 1975; Mathieson, et al., 2001). The Perceived User Resource (PUR) model or extension of the original TAM model accounts for the user's perception of the relevance or adequacy of a given technology. Pursuing this extension of the TAM framework, we desire to analyze situations prevalent in countries or regions of the world where technologies are not readily available or accessible.

We extend the "The Influence of Perceived User Resources Model", which in turn is an extension of the original Technology Acceptance Model. For completeness, it should be mentioned that TAM's roots come from the Theory of Planned Behavior (TPB), which came from psychology research stream in the area of the Theory of Reasoned Action (Fishbein and Ajzen, 1975; Mathieson, et al., 2001).

Unlike the theory of planned behavior, TAM was developed to study the decision-making processes of users as to whether or not to adopt some information technology in various settings. Certainly, TAM has made major contributions to the field of Information Systems and development. A major reason for TAM's popularity is its practicality (relative to TPB). It is more parsimonious than TPB. Unlike TPB in which every situation requires unique operationalization, calling for the development of customized instruments for behavioral, normative, and control beliefs, TAM does not require such. Also, TAM has less constructs than TPB, making it easier to apply when predicting IS usage (Mathieson, et al., 2001).

In spite of its relevance and practicality, the original TAM model has some potential limitations when it comes to least developed countries. For example, TAM was based on studies in industrialized countries which enjoy widespread accessibility and familiarity with technologies. When it comes to Sub-Saharan Africa where technology availability is grossly inadequate, applying the TAM model in its original form may not be appropriate.

The Perceived User Resources Model

In developing a more appropriate model for Sub-Saharan Africa and other least developed countries, we start from the perceived user resource model (PUR) proposed by Mathieson, et al. in 2001. A detailed theoretical discussion of the perceived user resource model will not be presented in this paper, as that has already been presented by Mathieson, et al., [2001]. The Mathieson model which focuses on resource issues is shown in Figure 1.

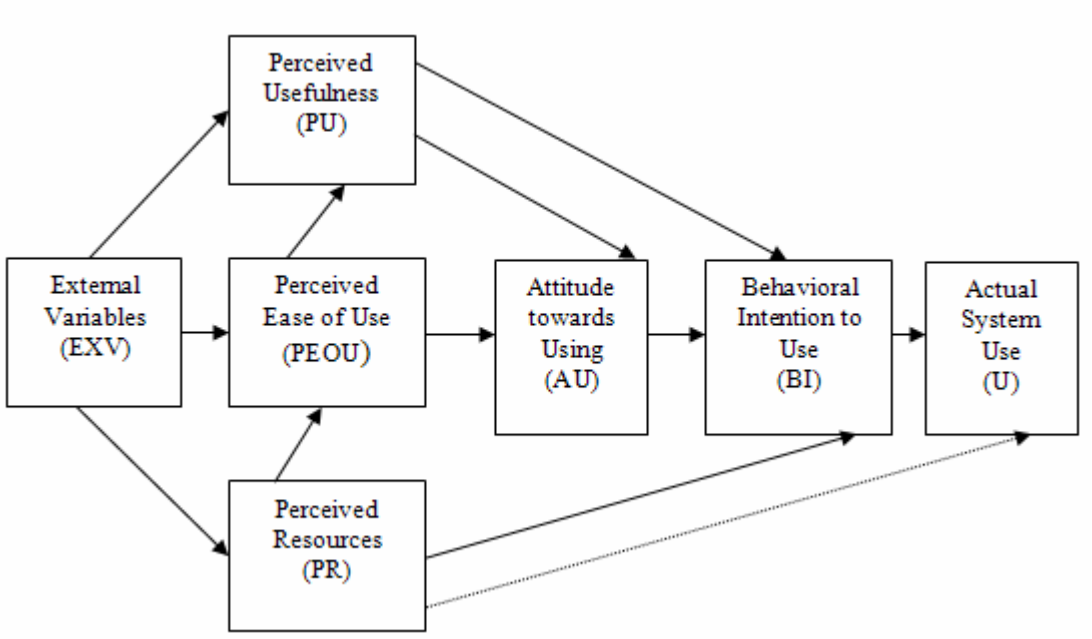

Figure 1: Influence of Perceived User Resource Model Extension from TAM

[Adapted from Mathieson, et al., 2001]

The rationale for focus on resource issues was based on the belief that it allows researchers, policy makers, and private investors a better delineation of factors over which managers may have some degree of control. This also helps keep the construct distinct from previously created constructs that deal with perceptions of users' abilities such as self-efficacy and skill (Compeau and Higgins, 1995; Mathieson, et al., 2001). In the Mathieson model (Figure 1), perceived user resources is designated by "PR", which is the extent to which an individual believes that he or she has the personal and organizational resources needed to use an Information System. The perceived user resources include factors such as skills, human assistance, hardware, software, time, documentation, and money (Mathieson, et al., 2001). In actuality, the factor "PR" is made up of reflective and formative components. The reflective component measures an overall perception of resource availability, while the formative components measure the perceptions of individual resources, such as expertise, training, hardware, money, etc. Since these items capture different resources, they are not necessarily correlated (Mathieson, et al., 2001). Previous research papers show that perceived usefulness and perceived ease of use are both predictors of technology adoption by individuals, with perceived usefulness being the stronger of the two (Davis, et al. 1989; Gefen and Straub, 1997;

Gefen et al., 2003; Grover and Ramanhal, 1999; Malhotra and Galletta, 1999; Mathieson, et al., 2001; Venkatesh and Morris, 2000).

The Revised TAM: Accounting for Accessibility and Exposure to Technology

Our extension of TAM model that accounts for the accessibility and exposure (or lack thereof) to information technology is given in Figure 2. The new model incorporates the linkages between factors of national development (socio-economic development) and technological infrastructure (as captured by accessibility to technology). The model also captures individuals' perceptions of the negative and positive impact factors.

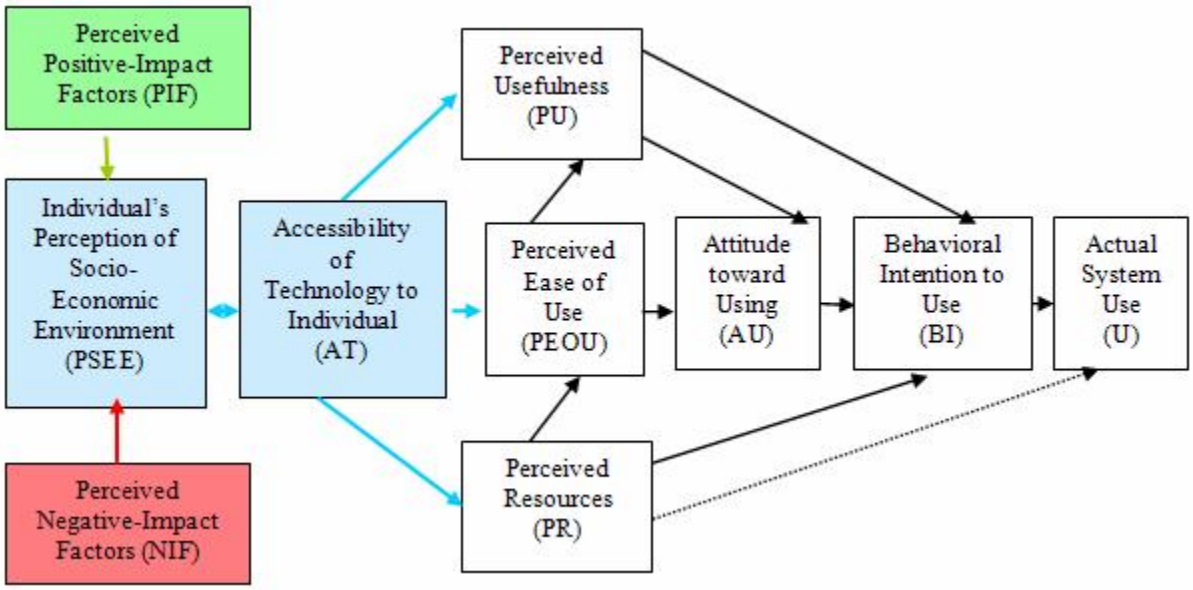

Figure 2: The Revised TAM: Accounting for Accessibility of Technology

VALIDATION OF THE REVISED MODEL

We used a survey and the structural equation modelling statistical approach to empirically examine and validate the model. We developed the survey instrument -- a questionnaire -- to measure individuals' perceptions of technology and core factors that we thought would influence an end-user's propensity toward adoption. We caution that the claim is not to generalize the results from this preliminary study to apply developing countries, as there may be differences socio-economic, cultural, linguistic, and other factors (Nhampossa, 2004; Alampay, et al., 2002). More emphasis should be placed on how these factors affect adoption of technology for development, rather than merely measuring the factors.

Sub-Saharan Africa, as a region is geographically rather large and surveying each individual country proved impractical. Therefore, for this initial study, we selected to limit our data collection to Nigeria and Kenya, both of which use English as the formal language for education. This allowed for more effective administration of the survey instrument without the need for translators or intermediation. As mentioned below, future research will be expanded to other countries in which other languages such as French and Portuguese are used in schools.

In constructing the instrument, we gave preference to previously tested questions and followed generally accepted guidelines for building survey instruments (Gefen et al., 2003; Wixom and Watson, 2001). We developed the survey items from validated instruments and used them only when the existing literature adequately supported them. We gave the initial survey instrument to researchers from US academic institutions with specific expertise in technology transfer and IT diffusion in

Africa. We then used their input to refine and restructure the instrument and establish its content validity. Finally, we pilot-tested the instrument with five academicians and practitioners, who were natives of sub-Saharan Africa, to identify problems with wording, content, structure, format, and procedures. The pilot participants returned written comments, and we followed up with each one via telephone for more detailed feedback. We used their recommendations to develop the final version of the instrument

We then sent 450 hardcopy questionnaires to two agent organizations in Nigeria and 150 to two similar organizations in Kenya. The agent organizations have several branch offices in the respective countries, and they distributed the questionnaires to each of their branch offices. The branch offices disseminated the questionnaires to workers in government ministries, as well as staff and faculty at local universities and polytechnic institutes. We offered no incentives for completing the questionnaire. As indicated in Table 1, the educational levels of the subjects varied greatly, depending on job function. While the choice of countries and subjects targeted in this initial effort was largely driven by logistics, we plan to include more countries and demographics in future research (Musa, 2006)

Out of the 600 questionnaires distributed, we received 198 responses from 122 males and 76 females -- a satisfactory 33% response rate. The 198 respondents ranged in age from 18 to 60 years, and had an average work experience of 8.18 years. On average, the respondents indicated that they had completed at least a high school education (except for one respondent from Kenya who indicated no formal education). We used the Likert scale to measure all survey items, except those that provided personal information about the individual.

TABLE 1: Descriptive Statistics of Respondents by Country

ITEM	Country	Valid N	Minimum	Maximum	Mean	Std. Deviation
Age	Both	187	18	60	32.813	8.649
	Nigeria	150	20	60	33.427	8.835
	Kenya	37	18	60	30.324	7.450
Work Experience	Both	160	0	31	8.186	6.685
	Nigeria	125	0	27	9.168	6.615
	Kenya	35	0	31	4.686	5.769
Education Level*	Both	165	1	6	3.879	0.832
	Nigeria	131	2	6	3.977	0.827
	Kenya	34	1	5	3.500	0.749

*NOTE: * Likert scale of 1 to 6 used to measure education level with 1=no formal education, 2=primary or elementary certificate, 3=high school certificate, 4= bachelors degree or equivalent, 5= masters degree or equivalent, and 6= doctoral degree or equivalent; N=number of cases used in determining mean and std. Dev.*

We tested the research model using Partial Least Squares (PLS); a structural modelling technique well suited for highly complex predictive models (Chin, 1997; Gefen et al., 2003; Joreskog and Wold, 1982; Wixom and Watson, 2001). All reliability measures were above the recommended level of 0.60 for exploratory research (Nunnally, 1967; Wixom and Watson, 2001). Detailed summary table of results, factor loadings, and path coefficients would be presented at the conference.

OBSERVATIONS AND LIMITATIONS OF STUDY

Although the results from this initial attempt to understand how some factors affect technology adoption for development do favor the need for a strategy of incremental deployment of technology, we must caution that the results may not be generalizable (Nhampossa, 2004). To address the limitations of this study in regards to number of countries and selection of subjects, we plan to include other countries and more diverse demographics of subjects in future studies. We also caution that emphasis should be placed on how the factors discussed in this study affect adoption of technology for development, rather than on the measurement of the factors.

Based on this and some past studies, we suggest that flooding the region with even the best and latest technologies may not lead to sustainable development that would benefit the masses. Past research indicates that sudden exposure to technology does not usually lead to meaningful usage, application, or concomitant acquisition of knowledge. Our findings and recommendations are supported by lessons learned from past research in other parts of the world (Odedra-Straub, 1996;

Madon, 2000; Sahay and Avgerou, 2002; Sein and Harindranath, 2004). However, the fact that the region has segments that are technologically advanced leads us to call for multiple policies so that technological entrepreneurs are not penalized by a policy of gradualism.

We propose that a more reasonable starting point would be to harness ICTs in areas such as the improvement of basic health, education, steady electricity and water supply, telecommunications networks, governance, the alleviation of hunger, poverty, and the conservation of the physical environment, etc. Pursuing these key areas would enhance human development across the region, and also allow for the culturation of technology in the local and cultural contexts.

In order for the masses to benefit from the potentials of modern information technologies in the delivery of education and other needs, basic infrastructures such as school buildings and steady electricity supply that support such technologies must be put in place. ICTs that reach out to rural areas could then be implemented to support education and other needs such as healthcare, roads, agriculture, and manufacturing. With the proper strategy, the world's technological desert could become an oasis of technological use, development, and production before too long.

We propose that providing the populace with these and other basic needs, starting with the infrastructures that target basic healthcare and education would allow them to move to higher levels in their hierarchy of awareness and needs. It is when one has basic health and education, access to potable drinking water, roads, electricity, television, telephone, etc., that his or her horizon could extend to other matters such acquiring and applying more modern technologies to their full potential. We feel that sustainable development will continue to elude Africa until the factors (mentioned above) that curtail improvements in socio-economic, human, and technology development are understood and addressed.

CONCLUDING REMARKS

While it is true that there has been significant growth in mobile communications devices (cell phones) across Africa in the past five years, most of the use has been for portrayal of status symbol and socialization, rather than transacting e-commerce or m-commerce (Myers, 1997; Raghuram, 1996; Motorola, 2003; Meso, et al, 2005). We believe that true benefit of technology comes from meaningful application to enhance standards of living, which comes from systematic unrestricted access to technology over time and within the right social and cultural context.

The contribution of this study has been to enhance our understanding of the interactions that come to bear between socio-economic and human development needs and factors generally innate to Sub-Saharan Africa and other less developed regions that manifest to impede technological accessibility, exposure and therefore adoption. We have argued that Sub-Saharan Africa has some factors that do not show up in the conventional Technology Acceptance Model, whose premise was based on settings that are essentially applicable to industrialized nations. By extending the influence of the perceived user resource model, which in turn was developed from the original TAM literature (Davis, et al., 1989; Mathieson, et al., 2001), and borrowing from ideas espoused in socio-economic development literature (e.g., Morales-Gomez and Melesse, 1998; Madon, 2000; Sahay and Avgerou, 2002; Sein and Harindranath, 2004), we developed an extended model that accounts for technology availability. Although not necessarily generalisable, this new model enhances the understanding of technology adoption that captures the context of Sub-Saharan Africa and other developing regions of the world.

We have presented PLS results based on survey data collected in Sub-Saharan Africa that supports our new model and call for a new and systematic approach to economic and technology development in Sub-Saharan Africa. We recognize the need to support those that are already ahead in the technological learning curve.

We have attempted to show the links between socio-economic development and technology adoption. On a global scale, it could be argued that these findings may be applicable to certain situation in developed countries such as the U.S. and others, where a digital divide exists along income and education levels, as well as along race, age and other variables (The Citizen, 1996; The Globe and Mail, 1996; Moreles-Gomez and Melesse, 1998). Future studies would shed some light on the relevance of this and other observations made in this paper.

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