Communications of the Association for Information Systems

Volume 15 Article 33

April 2005

Toward Sustainable Adoption of Technologies for Human Development in Sub-Saharan Africa: Precursors, Diagnostics, and Prescriptions

Philip F. Musa
University of Alabama Birmingham, musa@uab.edu

Peter Meso
Georgia State University, pnmeso@gmail.com

Victor W. A. Mbarika
Southern University, victor@mbarika.com

Recommended Citation
Musa, Philip F.; Meso, Peter; and Mbarika, Victor W. A. (2005) "Toward Sustainable Adoption of Technologies for Human Development in Sub-Saharan Africa: Precursors, Diagnostics, and Prescriptions," *Communications of the Association for Information Systems*: Vol. 15 , Article 33.
DOI: 10.17705/1CAIS.01533
Available at: https://aisel.aisnet.org/cais/vol15/iss1/33

Communications of the Association for Information Systems

TOWARD SUSTAINABLE ADOPTION OF TECHNOLOGIES FOR HUMAN DEVELOPMENT IN SUB-SAHARAN AFRICA: PRECURSORS, DIAGNOSTICS, AND PRESCRIPTIONS

Philip F. Musa
School of Business
The University of Alabama at Birmingham
musa@uab.edu

Peter Meso
College of Business
Georgia State University

Victor W. Mbarika
College of Business
Southern University

ABSTRACT

This paper proposes and merges an extension of technology acceptance model with ideas from human development research targeting least developed countries. Specifically, the paper proposes an extension of the influence of perceived user resource, which in turn was developed from the original TAM literature. It is also tied to the Information Technology literature about socio-economic development. Our objective is to shed light on the interactions between socio-economic development needs and factors generally innate to sub-Sahara Africa and other developing countries that impede sustainable technological adoption and diffusion. We argue that developing countries lag in adopting 'foreign technologies'. We offer diagnostics and prescriptions for how to effect a sustainable technological adoption to support socio-economic development across Sub-Saharan Africa. This article should bring into focus this and other developing regions that are almost non-existent in mainstream Information Systems research.

Key Words: accessibility, technology infrastructure, exposure, Sub-Saharan Africa, least developed countries, less developed countries, socio-economic development, human development, precursors to adoption, negative-impact factors, positive-impact factors, and modified tam.

I. INTRODUCTION AND CALLING FOR FOCUS ON SUB-SAHARAN AFRICA

Sub-Saharan Africa[1] remains in a state of a quandary as to how best to participate in the global information age. For a region that historically lagged the world in most aspects of development, the age of technology presents new challenges. Since the region does not contain adequate technological infrastructure nor went through the requisite technology learning curve, it risks falling even further behind if the right strategies for catching up with the rest of the world are not pursued. It may be easy to say we should just flood the region with modern technologies, but by and large this strategy did not work for most developing countries,. This strategy is tantamount to providing someone with fish rather than teaching them how best to fish [Morales-Gomez and Melesse, 1998; Sein and Harindranth, 2004]. The fish simile does not capture the Information and Communication Technology (ICT) scenario adequately, inasmuch as technologies are not simple artifacts. Their meaningful use and application depend on factors such as local contents and culture.

It is not surprising that meaningful transfer and adoption of technology, with a focus on improving human development across Sub-Saharan Africa remains problematic and with unfulfilled dreams. While some people may rejoice over the recent increases in the number of mobile communication devices such as cellular phones in the region, they fail to realize that by and large, these devices are not being used to enhance the socio-economic development of the region, but for social communication and exhibiting a status symbol. Computing devices such as laptops are available to a negligibly small proportion of the population – mainly the wealthy and high-level executives who reside in urban areas. Meanwhile, most of the region's inhabitants continue to grapple with life's daily challenges, with no electricity, running water, paved roads, or affordable healthcare, coupled with poor educational and telecommunication infrastructures.

The success of Sub-Saharan Africa and other developing regions is in the interest of the whole world. 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]. Developing countries make up 75% of the world's population and currently share only 16% of the world's products [Sahay and Avgerou, 2002 p.74]. The potential to make the world a much better place is huge. Mainstream Information Systems research with a focus on developing countries and the sub-Saharan African region is rare [Sahay and Avgerou, 2002, p.74].

One of the motivations for this paper is to enhance our understanding of the interactions between socio-economic development needs and factors specific to Sub-Sahara Africa and other developing countries. These interactions impede technological transfer, adoption, and diffusion in these regions. We believe that developing countries lag in adopting modern technologies for various reasons, among which are geo-political, cultural, structural, tribal, environmental and socio-economic policy factors. Understanding these factors would help policy makers, IT practitioners, donor organizations, private investors, and others devise meaningful policies that would help the region reach its true potential. We believe that the programmed approach we propose would help transform the technological deserts into oases of technological use, development, and production. We already know that many band-aid approaches were tried and failed.

We could learn much from the experiences of developed and even some developing countries in this endeavor. Not too long ago, countries such as India, Malaysia, Singapore, and Mexico were little known in terms of technological competitiveness. Today, these countries generate billions of dollars by winning lucrative systems design, coding, and production contracts from the most industrialized parts of the world. Although there are some growing pains and unanswered questions about their efforts, they are getting ahead of the curve relative to Sub-Saharan Africa [Madon, 1997].

---

[1] Sub-Saharan Africa is made up of 43 countries (see Appendix I for a list of countries and a map of the region).

II. TAMING THE BEAST—OUTLINE OF THE PAPER

Often donor organizations, government agencies, and even researchers are quick to assume that information systems technologies, theories, or models developed elsewhere could be transferred and adopted in Sub-Saharan Africa and other less developed[2] regions for the use intended. We feel this approach often fails for various reasons. Since ICTs are not simple artifacts, it would seem reasonable that we cannot simply extrapolate the experiences from the developed nations to technology transfer, diffusion, or adoption to apply to developing regions such as Sub-Saharan Africa. Furthermore, we believe that socio-economic development level is intimately tied to technology diffusion, adoption, and acculturation. These attributes generally call for universal access and exposure to basic technologies which could lead to the refinement of mental models and meaningful application of technologies to address the relevant local problems in the right cultural contexts. The result is enhanced human development, which is the ultimate goal.

In addition to making the case that meaningful ICT use and application are those that enhance human development, we develop a model that extends the influence of the perceived user resource model. Our new model captures situations applicable to Sub-Saharan Africa and other less developed countries. Furthermore, we present responses to the following questions to strengthen our call for using human development as a basis for measuring ICT adoption and diffusion. The questions to be addressed in sequence are:

1. What problems exist in Sub-Saharan Africa to which technological interventions could provide sustainable solutions?
2. What factors or forces conspire to keep the region's technological adoption historically grossly inadequate?
3. How do these factors or forces tend to interact with socio-economic development levels?
4. How could we then relate a region's socio-economic development level with the region's realizable technology adoption and diffusion?
5. How can we modify the Technology Acceptance Model to capture the prevailing realities in Sub-Saharan Africa?
6. How could the integration of the above factors help prescribe a more relevant strategy for Sub-Saharan Africa and other developing countries?

To address these questions, we start by presenting an overview of what we believe to be some of the serious human development problems that the region faces and for which we call for the urgent, programmed use of technology to tackle (Section III). To make our point, we present some world statistics to show just how bad the various human development indices are across the region, relative to most parts of the world.

We then outline what we believe to be some of the reasons that led to the historically gross inadequacy of technology, and therefore its low impact in social development across Sub-Saharan Africa. As presented in section III, there are two types of forces that impinge on the region's socio-economic development needs:

1. One set of forces is positive in nature; which means that they tend to provide an impetus for policy makers and other investors to embark on substantive measures to enhance socio-economic development.

2. Another set of forces impinge on socio-economic development needs negatively. These forces tend to result in policies that retard any meaningful steps toward socio-economic development and technological adoption.

[2] In what follows in this paper we use the term sub-Sahara Africa as a shorthand to refer to both this region and to other less developed countries.

We argue that if the right strategies are pursued, the ingenuity, entrepreneurship, resilience, and desire to participate fully in the information age by the average African would allow the region to reach acceptable living standards sooner than later.

We then begin the development of our ultimate model that ties socio-economic development to technology adoption. We suggest that accessibility and exposure to technology precedes sustainable adoption to solve local problems in order to enhance human development. It should be noted that the inter-relatedness between a region's socio-economic development level and its technological advancement (e.g., in terms of adoption, diffusion) is well-recognized [The Panos Institute, 1998; Mbarika, et al., 2002].

While Section III presents what we believe to be the pertinent factors that affect socio-economic development across the region, we present how socio-economic development in turn interacts with technology adoption and diffusion in Section IV.

In Section V, we begin the process of developing an extension of TAM that captures the prevailing situations across Sub-Saharan Africa. We borrow from development as well as technology adoption literatures. We focus on one of the extensions of the original TAM model (Perceived User Resources model) as our starting point. A brief overview of the Perceived User Resources model is presented in Section VI. Subsequent to that, we develop our revised TAM model for least developed regions of the world (such as Sub-Saharan Africa) in Section VII. In Section VIII, we present some diagnostics and prescriptions for how best to effect sustainable technological transfer and adoption strategies for Sub-Saharan Africa. Concluding remarks and directions for future research are given in Section IX. To set the stage for the rest of this paper, the following sub-section speaks to the need for technological interventions that focus on improving human development indices in Sub-Saharan Africa.

SERIOUS PROBLEMS THAT CALL FOR TECHNOLOGY INTERVENTION

We propose that ultimately, ICT adoption and diffusion in the developing world are best measured in terms of their impact on socio-economic development (as measured by human development indices). As it stands, Sub-Saharan Africa remains in the doldrums in most world human development indices. We present examples of these indices, and then examine factors responsible for the historically poor human development statistics and socio-economic development relative to the rest of the world.

The Not so Rosy Statistics: Some Examples

Telecommunications infrastructure across Sub-Saharan Africa remains grossly sub-standard, as evidenced by historically limited number of landline telephones across the region. Because of the limited size and outdated nature of telephone exchange systems across the region, it is not uncommon for potential subscribers to wait for over ten years without ever receiving a phone line, despite paying the expected bribery money to telephone workers. As in many developing regions of the world, lack of competition is cited as one of the causes for many of Africa's problems. Industries such as telecommunications, airlines, railway, water, and electricity, are government monopolies.

Over the years in Sub-Saharan Africa the average teledensity (telephone lines per 100 people) across the region is less than 1.0, compared to an average of about 65 for developed countries, many of which have teledensity numbers approaching 100, not counting cell phones [ITU, 2004]. It is estimated that there are more telephone lines in New York City than in all of Africa [Mbarika, et al., 2002]. The meager numbers across Africa are a symptom of a larger problem – an indication of poor socio-economic development level, since the two go together [The Panos Institute, 1998].

When it comes to Internet dialup, only a paltry 150,000 out of the 690 million people in the region had the service as of 2001[3]. That is, only 2 out 1,000 people could access to this luxury privately, compared to developed regions of the world such as the United States, where the Internet dialup access for the same period stood at 3 per 10 people [Jensen, 2001; ITU, 2004]. Statistics from the same period showed that PC density for Sub-Saharan Africa was only 0.1%, compared to 42% in the U.S. [ITU, 2001].

Illiteracy remains a serious problem for most of Sub-Saharan Africa. The severity of this problem is evidenced by United Nations Educational, Scientific and Cultural Organization (UNESCO) which indicated that about 40% of the people were illiterate. Adding the effects of functional illiteracy and unemployment for those that managed to obtain some education, the situation is quite bleak [UNESCO, 2002].

The problem of illiteracy is amplified by the deteriorating education system, including dilapidated school buildings and serious shortages of supplies across the region. Most citizens cannot access running water or electricity; for the few that do, electricity outage is the norm rather than exception. Less than 13% of the roads in the region are paved, making most places inaccessible, especially in the rainy seasons [World Development, 2004].

The high illiteracy and poverty rates in Sub-Saharan Africa translate into poor newspaper circulation, and TV and radio ownership. The 1994 statistics per 1,000 people for all of Africa are summarized in Table 1. Since the data in Table 1 include North African countries; the numbers for the Sub-Saharan region are much lower than those shown. We argue that a programmed transfer and adoption of technology in the right social and cultural contexts will improve all these statistics.

Table 1. Newspaper Circulation, TV, and Radio Ownership by Region

Region	Newspaper Circulation	Radio Ownership	TV Ownership
Africa	15*	40*	163*
North America	200	751	1600
Europe	244	392	605
Asia	120	175	300

Source: United Nations Educational, Scientific, and Cultural Organization [UNESCO, 1996].
*Includes North African countries. Values for Sub-Saharan Africa only would be much lower than those shown in the table.
**Numbers are per 1000 population

Sub-Saharan Africa also lags the rest of the world in health care. Statistics ranging from infant mortality, life expectancy, HIV/AIDS infection rates, to number of nurses and physicians per capita, are totally unacceptable in today's world. The region's infant mortality rate of 103 per 1,000 live births is the worst in the world [World Almanac, 2003]. This mortality rate is due in part to the poor quality of drinking water, coupled with other environmental-related problems. Death rates due to malaria, typhoid, jaundice, and other diseases are catastrophic. While developed countries classify polio as eradicated, the World Health Organization reported the spread of this debilitating disease across Sub-Saharan Africa [Fowler, 2004]. Even before the effect of HIV/AIDS is factored in, life expectancy in many countries in the region is less than 40 years, compared to the 70s and 80s that are common in many parts of the world [CIA World Fact, 2004]. The United Nations indicates that the world is losing the battle against AIDS, especially in Africa. The report cites that 25 million out of the estimated 38 million people afflicted with HIV/AIDS in

[3] Cyber cafés, popular in countries such as Togo [Bernstein and Goodman, 2005], add people with access. However, the number of people who can use the Internet is still remarkably small.

the world live in Sub-Saharan Africa [Ross, 2004]. We suggest that a programmed transfer of basic technologies to educate the masses of people in healthcare and prevention interventions would help control the spread of the HIV/AIDS epidemic and numerous other diseases in the region. The situations compel us to emphasize prevention instead of seeking for cures, which for the most part are either unavailable or too expensive for most people in the region.

While space precludes us from documenting many other human development indices, we believe that we illustrated some of the numerous serious problems that afflict the region. Furthermore, we believe that developing a solution to a problem comes with identifying and accepting the problem, followed by proper diagnoses, prescription, and proper administration of treatment. We believe that proper formulation and implementation of technology strategies offers a unique opportunity for Sub-Saharan Africa to be fully integrated with the rest of the world.

III. FACTORS THAT INTERACT WITH SOCIO-ECONOMIC DEVELOPMENT TO KEEP SUB-SAHARAN AFRICA IN THE DOLDRUMS

The region is saddled with many negative-impact forces or factors with negative interactions and consequences on socio-economic development and therefore on technology innovation, diffusion, and adoption across much of Sub-Saharan Africa. These factors are summarized in Table 2. Although there are some positive-impact factors (also given in Table 2) that attempt to enhance socio-economic development and integration into the world economy, the effects of the negative-impact forces are so overwhelming that the net results are the poor human development statistics given in Section II [Madon, 2000; Sein and Harindranath, 2004]. It is our belief that sustainable growth should start with re-enforcing the positive impact factors while mitigating the negative impact factors. From this effort, the seeds of sustainable socio-economic development would germinate and prosper. When basic technologies are then introduced in the right local contexts, systematic exposure to such technologies leads to refinements of mental models and increased capacities to apply even more sophisticated technologies to enhance human development needs.

Table 2. The Negative-Impact and Positive-Impact Factors in Development

Negative-Impact Forces or Factors	**Positive-Impact Forces or Factors**
1. Lack of vision 2. Corruption 3. Lawlessness 4. Tribal and religious strife 5. Natural disasters (e.g., draught, locusts, etc.) 6. Military and civilian dictatorships 7. Inadequate technological infrastructure 8. Inadequate educational infrastructure 9. Finger-pointing to colonial master-plans 10. Apathy 11. Investments in obsolete or hand-me-down technologies 12. Governments' failure or refusal to provide the populace with life's basic amenities (e.g., water, roads, electricity, healthcare, education, employment, etc.) to maintain control.	1. World pressure for democracy and good governance 2. Desire to improve infrastructures such as technology, education, health, economic productivity, social well-being, but greed gets in the way.

IV. HOW SOCIO-ECONOMIC DEVELOPMENT INTERACTS WITH TECHNOLOGY ADOPTION AND DIFFUSION

We now move to our proposition of how socio-economic development in turn interacts with actual adoption and diffusion of technologies in a region. As shown in Figure 1, "Adoption and Diffusion of Technologies for Human Development" interact with "Socio-economic Development Level" through a third factor "Accessibility and Exposure to Technologies". This relationship underscores the importance of systematic accessibility and exposure to technology over time as a vehicle to sustainable adoption of technologies for development.

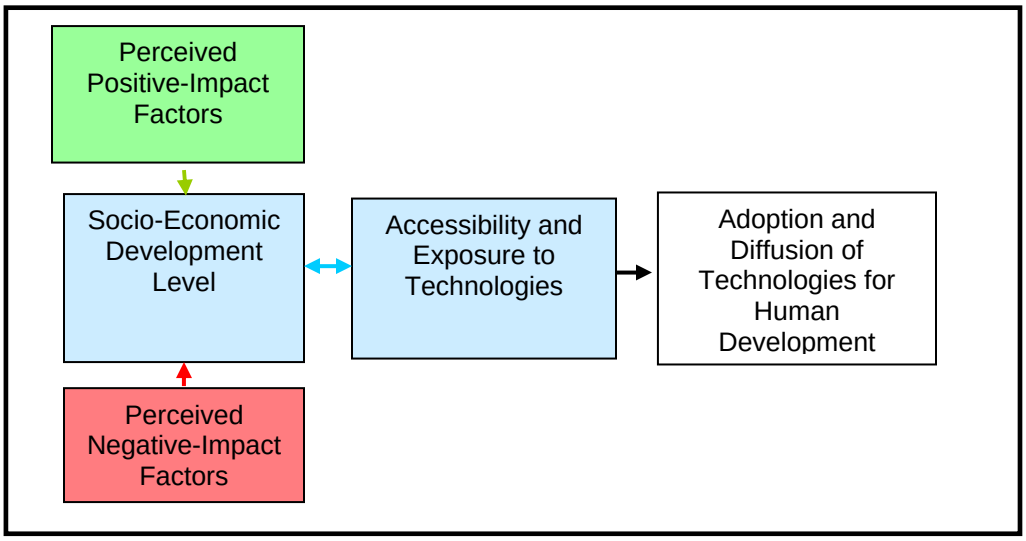


Figure 1. Relating Socio-Economic Development, Accessibility, and Exposure to Technology Adoption and Diffusion

As noted in Figure 1, the interaction between "Socio-Economic Development Level" and "Accessibility and Exposure to Technologies" is two-way. We suggest that basic technologies (those that support, e.g., farming, healthcare, education) provide the initial positive feedback loop between the two. All other things being equal, the initial introduction of appropriate technology serves as a catalyst to socio-economic development. From here, national governments, international agencies, and other investors could design appropriate policies and programs that enable poor countries to harness ICTs for development in their own contexts [Morales-Gomez and Melesse, 1998; UNDP, 2001]. Given the right atmosphere, the re-enforcing positive feedbacks would then keep feeding on itself.

The box labeled "Accessibility and Exposure to Technologies" in Figure 1 refers to the technologies that are in place and universally available for use. These technologies include related ICTs such as computers, telecommunications networks, Internet, or any machinery or equipment that constitutes "a technology" in a user's world. Note, however that merely providing access to technology is one thing, but the maturity and exposure to the use of related technologies over time and the existence of appropriate technological infrastructure in a given region significantly helps a given technology to reach its full potential.

We believe that Sub-Saharan Africa's long term needs are best served by incremental developments. We do not believe that meaningful and sustainable developments would be realized by flooding the region with even the best and latest technologies at this point. Lessons learned from other developing regions show that sudden exposure to technology does not guarantee meaningful usage or concomitant acquisition of knowledge [Odedra-Straub, 1996; Madon, 2000; Sahay and Avgerou, 2002; Sein and Harindranath, 2004]. Furthermore, access to information sources such as the Internet tends to be correlated to income and socio-economic status [Oyelaran-Oyeyinka and Adeya 2002]. Therefore, it is best to embark on programmed transfer strategies that would bring about more universal access and exposure to facilitate meaningful use for human development.

V. BACKGROUND LITERATURE ON DEVELOPMENT OF A NEW TAM FOR SUB-SAHARAN AFRICA

Most research on innovation adoption and diffusion, especially in the rapid growth area of Information Technology, focuses on developed countries [Mathieson et al., 2001; Straub, 1994; Gallivan, 2001]. Most of technology adoption research presumes that technology is readily available, and that the responsibility for accepting or rejecting it resides with the end user. This assumption falls short of realities in the least developed regions such as Sub-Saharan Africa. As discussed in Section II, countries in this region lag behind the rest of the world in basic socio-economic factors which are pertinent to the day-to-day use of modern technologies [Meso and Mbarika, 2005]. To the vast majority of potential users in developing countries, adoption is not about choice, since universal access and exposure to technology is not available.

Despite the many models and studies on technology adoption in mainstream IS research, we did not find studies that examine technology adoption and its precursors in the sub-Saharan African context. Previous research was mostly done in the context of developed economies. Several researchers also report that existing technology adoption models, for example TAM, omit variables that may be important predictors of usage [Mathieson et al., 2001; de Vreede et al., 1999; Malhotra and Galletta, 1999]. Our study therefore sets out to develop a model of technology adoption that accounts for some dynamics and precursors that come to play in the context of Sub-Saharan Africa. We believe that this new model should shed some light on the uniqueness of the region.

We posit that access and exposure to basic forms of technology over a period of time allows for a much easier progression to and application of more advanced types of technologies to aid in human development efforts. The chant for developing countries to jump on the technology superhighway band wagon or be doomed needs a programmed approach, rather than the tried-and-failed band-aid approaches. Technologies are not simple artifacts that could be adopted by all societies regardless of historical, cultural, or socio-economic conditions.

While we do not claim that there is complete, unlimited access to technology for those who live in developed countries such as the United States, it is hard to deny the relative ease of outright ownership or access to ICTs by those who live in developed countries through various means such as public libraries, schools, hotels, recreation centers, and work places. 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 were exposed to technology over many years. The situation in Sub-Saharan Africa is understandably different.

We built our model to include the local circumstances in Sub-Saharan Africa. Our study builds on the works of other researchers that made notable contributions to 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 add to the discussion by gathering data from Sub-Saharan Africa to help us understand 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. We believe that the new TAM model presented

here would be more relevant to Sub-Saharan Africa and the least developed regions of the world where universal access to ICTs and sustainable economic development remain illusory. In the following sub-section we begin the process of extending the perceived user resource model in order to build a new version of the technology adoption model for Sub-Saharan Africa.

THE INFLUENCE OF PERCEIVED USER RESOURCES IN TECHNOLOGY ADOPTION: THE BACKGROUND

Several theoretical frameworks are used to explain innovation adoption. Among them are the theory of planned behavior, theory of reasoned action, diffusion of innovations, social cognitive theory, and the technology acceptance model [Gallivan, 2001]. An area of innovation adoption and diffusion that receives considerable attention, especially in Information Technology, is research that predicts whether individuals will accept and voluntarily use a given technology. One of the most referenced models in this research stream is the Technology Acceptance Model (TAM). TAM proposes that successful adoption (acceptance) of technology is dependent on its usefulness and its ease-of-use [Davis, et al., 1989].

Researchers study 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 (Section VI), which we extend further and is an 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 want to focus on situations prevalent in countries or regions of the world where access and exposure to technologies are not the norm.

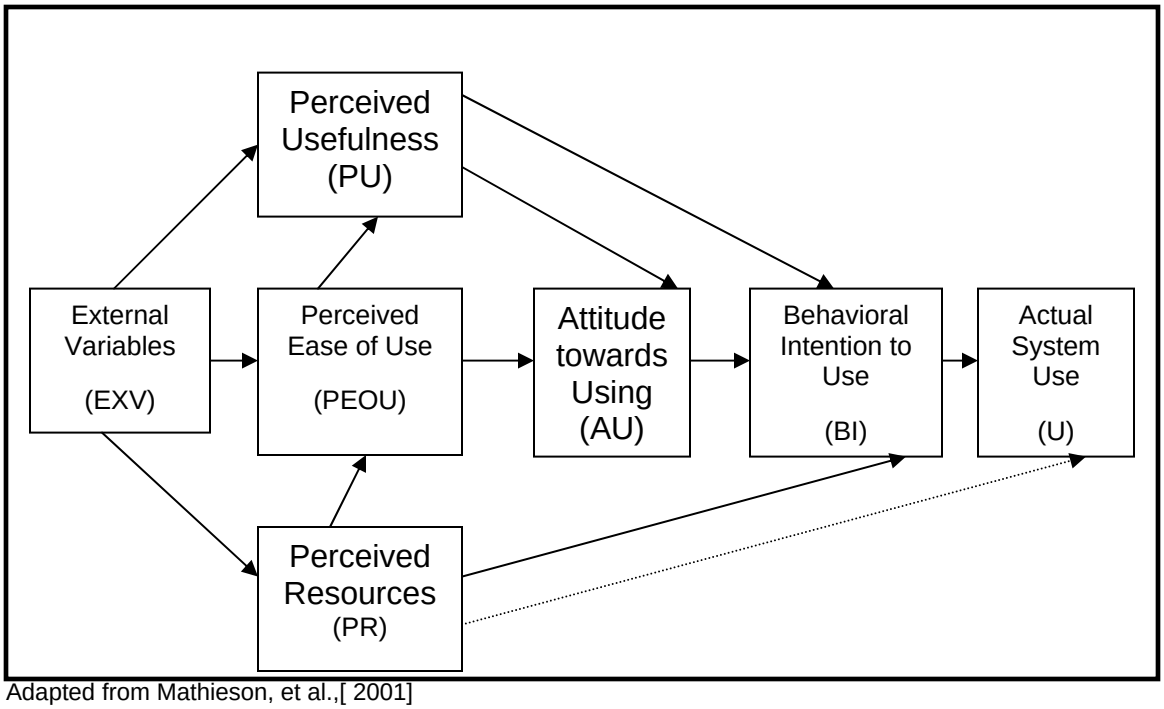
TAM's roots come from the theory of planned behavior (TPB), which came from psychology research on the theory of reasoned action [Fishbein and Ajzen, 1975; Mathieson, et al., 2001]. Unlike the theory of planned behavior, TAM was developed to study the decision-making processes of users as to whether or not to adopt information technology in given settings. A major reason for TAM's popularity is its practicality (relative to TPB). It is more parsimonious than TPB. TAM does not require TPB's unique operationalization in every situation, calling for the development of customized instruments for behavioral, normative, and control beliefs. Also, TAM includes fewer 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 is potentially limited when it comes to Sub-Saharan Africa. For example, TAM was based on studies in industrialized countries where accessibility to technologies already existed. Because in Sub-Saharan Africa technology availability is grossly inadequate, using the TAM model in its original form would be a stretch.

VI. MODEL OF THE INFLUENCE OF PERCEIVED USER RESOURCES IN TAM

In developing a more appropriate model for Sub-Saharan Africa and other less developed countries, we start from the perceived user resource model (PUR) proposed by Mathieson, et al. [2001]. The justification for focusing on and extending from PUR is that the PUR model already extends the original TAM model to account for users' perceptions of the resources at their disposal. We develop a model that explicitly recognizes the non-universal availability of technology in the least developed parts of the world[4]. The Mathieson model, which focuses on resource issues, is shown in Figure 2. The rationale for starting from this model is that it is already resource-oriented.

[4] For a detailed theoretical discussion of the PUR model, see Mathieson et al. [2001]



Adapted from Mathieson, et al.,[2001]

Figure 2: Influence of Perceived User Resource Model Extension from TAM

In Figure 2, perceived user resources are designated by "PR", which is the extent to which an individual believes that the personal and organizational resources needed to use an Information System are available. The perceived user resources include factors such as skills, human assistance, hardware, software, time, documentation, and money [Mathieson, et al., 2001]. 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, and money. Since these items capture different resources, they are not necessarily correlated [Mathieson, et al., 2001]. Previous research shows 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].

VII. REVISED TAM FOR LEAST DEVELOPED COUNTRIES: ACCOUNTING FOR INADEQUATE ACCESSIBILITY AND EXPOSURE TO TECHNOLOGIES

The historically dilapidated technology infrastructures and the resulting poor human development indices across Sub-Saharan Africa were presented in Section II. We now present what we believe to be a relevant version of the TAM model for Sub-Saharan Africa. The model attempts to capture the problem of limited resources (in terms of accessibility and exposure) across the region, because resources are the major constraints to adoption and diffusion, and therefore human development initiatives.

Our extension of TAM model that accounts for the accessibility and exposure (or lack thereof) to information technologies is given in Figure 3. The new model incorporates the linkages between factors of 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 that were presented in Section II. The new model provides the dynamics between socio-economic development as measured by human development indices and technology adoption that would further aid in national (human) development efforts. Before we shift the discussion to how best to effect sustainable technological adoption for development, we emphasize the overarching roles of accessibility and exposure in sustainable technology adoption and diffusion. The "Accessibility and Exposure to Technologies" in the new model shown in Figure 3 refers to the technology that is in place and available for use. These technologies include related ICTs such as computers, telecommunications networks, Internet, or any machinery or equipment that constitutes "a technology" in a user's world.

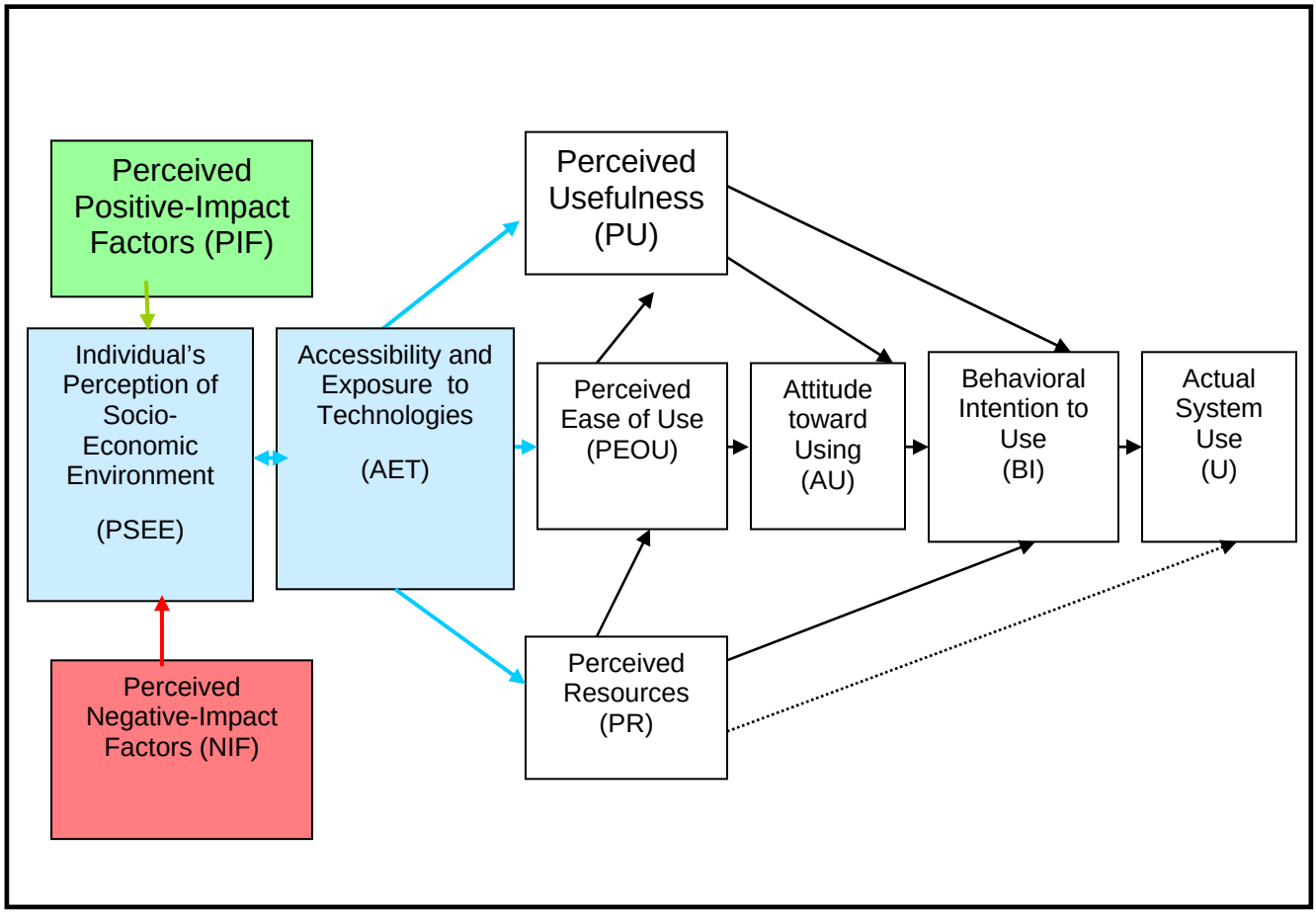


Figure 3: The Revised TAM: Accounting for Accessibility and Exposure to Technologies (Merging TAM with Socio-Economic Development)

The factors labeled "Perceived Positive-Impact Factors" and "Perceived Negative- Impact Factors" are made up of the precursors presented in Figure 2. In our model, these factors impact the object labeled "Individual's Perception of Socio-Economic Environment". As shown earlier in Figure 1 and Table 2, the positive impact factors are a collection of factors that tend to nudge a nation towards making substantive improvements in its socio-economic development[5], while the negative impact forces constitute major impedance to socio-economic development.

[5] Areas include: health, democracy, good governance, economic productivity, social well-being, the physical environment, roads, water and power supply, education, employment, and pressure or desire to integrate into the world economy

VIII. DIAGNOSIS AND PRESCRIPTIONS

That Sub-Saharan Africa lags the world in human development indices was demonstrated in Section II. The intervening role that technology could play in sustainable development was documented in this and other research efforts. We developed an extension of the perceived user resource model and pointed out the importance of accessibility and exposure to technologies in ultimate adoption. We also pointed out how the various factors in technology adoption and socio-economic development interact with each other.

Adequate technology adoption allows a country to realize the impact of technology. It is the impact of ICTs that is of most importance. Research on ICT impacts posits three levels or effects:

1. First-Order or primary effects (where there is simple substitution of old technologies by new ones). For example, access and ability to use a tractor alleviates the backbreaking hoe and hand-digger method of tilling the land. Another example is when telecommunication technologies provide faster alternatives to traditional means of communication (snail-mail). While realizing the primary effects does not generally imply development, it paves the way for higher order effects to take place [Sein and Harindranath, 2004 p.19].
2. Second-Order or secondary effects (where a phenomenon such as technology-enabled correspondence takes on a larger meaning, such as sharing of documents or graphics.). For example, this effect aids in co-authoring of research across vast geographical areas [Sein and Harindranath, 2004].
3. Third-Order or tertiary effects (the generation of new technology-related businesses and societal change). For example, the introduction of communication technology should spur the development of new businesses, for example electronic communication-enabled media such as virtual organizations [Sein and Harindranath, 2004 p.10].

We suggest that sustainable economic and human development would call for a systematic progression and maturation through these three effects.

As pointed out by S. Pitroda, advisor to the prime minister on technology missions for the Republic of India, proliferation of telecommunications in developed countries came after basic human needs (food, residence) were met [Sankar, 1994]. We believe that developing countries should learn a valuable lesson from that. With systematic and incremental approach to development, we believe that the developing countries such as those in Sub-Saharan Africa would be able to catch up with the rest of the world in a reasonable time frame. Therefore, we propose that a more reasonable starting point would be to harness ICTs improving the standard of living (Section II). Pursuing these key areas would enhance human development across the region, and also allow for the use of technology in the local and cultural contexts.

IX. CONCLUDING REMARKS AND FUTURE RESEARCH

While it is true that there mobile communications devices (cell phones) grew significantly across Africa in the past five years, most of the use is as a status symbol and for socialization, rather than transacting e-commerce or m-commerce [Myers, 1997; Motorola, 2003]. In addition to cellular phones, the number of people carrying laptop computers in Sub-Saharan Africa is increasing noticeably, but again it is mostly as a status symbol [Odunfa, 2003]. We believe that the 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.

This study enhances our understanding of the interactions between socio-economic and human development needs and factors in Sub-Saharan Africa that impede technological accessibility, exposure, and therefore adoption. We argue that some Sub-Saharan Africa factors do not show up in the conventional Technology Acceptance Model, because TAM's assumptions are 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 in the 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 accessibility and exposure. This new model enhances our understanding of technology adoption in situations such as Sub-Saharan Africa. The model should also be applicable to other developing regions of the world. We attempted to show the links between socio-economic development and technology adoption. On a global scale, these findings may be applicable to situations in developed countries where a digital divide exists along income and education levels, as well as along race, age and other variables [Moreles-Gomez and Melesse, 1998].

FUTURE DIRECTIONS

The model in this paper is an opportunity for further research from several perspectives. The validation of the model would require surveys across Sub-Saharan Africa and other less developed countries.

Although the UN and other agencies do conduct longitudinal studies on the diffusion of various ICTs, such as mobile ICTs, we plan to study the actual ways that individuals, micro-enterprises, and regular business organizations choose to employ mobile ICT and to examine how mobile ICT use differs from mobile ICT use in the advanced economies. There may be some adaptation of technology to culture; specific lessons learned could be extended to other less developed regions of the world (or even in underprivileged parts of developed countries).

Furthermore, it should be pointed out that Sub-Saharan Africa is a vast geographic region made up of countries that were colonized by different world powers. The economies of Anglophone countries historically were relatively disconnected from those of the Francophone countries within the region, and some countries, such as Mozambique and Angola, do not belong to either the Anglophone or the Francophone block. Surveying technology adoption practices across the different blocks may provide a further understanding of the ways technology adoptions and diffusions vary across the region.

We also propose that additional studies employing more qualitative approaches such as field-study or case-study methods be conducted in the region as ways of obtaining a deeper understanding of the factors that influence technology adoption and diffusion, investment decisions, and even government policies.

ACKOWLEDGMENTS

We extend much gratitude to various researchers whose works in the areas of “Information Technology for Development” [e.g., Madon, 2001; Morales-Gómez and Melesse, 1998; Odedra-Straub, 1996; Sein and Harindranath], and those who provided the foundation for our new TAM model for Sub-Saharan Africa and other least developed countries. The foundation models are the “Influence of Perceived User Resource” [e.g., Mathieson, et al., 2001], and finally, the original Technology Acceptance Model [Davis, et al., 1989].

Editor’s Note: This article was received on November 28, 2004 and was published on April 22, 2005.

REFERENCES

EDITOR'S NOTE: The following reference list contains the address of World Wide Web pages. Readers who have the ability to access the Web directly from their computer or are reading the paper on the Web, can gain direct access to these references. Readers are warned, however, that

> 1. these links existed as of the date of publication but are not guaranteed to be working thereafter.
>
> 2. the contents of Web pages may change over time. Where version information is provided in the References, different versions may not contain the information or the conclusions referenced.
>
> 3. the authors of the Web pages, not CAIS, are responsible for the accuracy of their content.
>
> 4. the author of this article, not CAIS, is responsible for the accuracy of the URL and version information.

CIA (2004) "The World Fact Book 2003" http://www.cia.gov/cia/publications/ factbook/ *(*Accessed May, 2004*)*

Davis, F. D., Bagozzi, R. P., and Warshaw, P. R., (1989), "User Acceptance of Computer Technology: A Comparison of Two Theoretical Models," *Management Science* (35) pp. 982-1003.

de Vreede, G. J., Jones, N., and Mgaya, R. J., (1999), "Exploring the Application and Acceptance of Group Support Systems in Africa," *Journal of Management Information Systems* (15)3, pp. 197.

Fishbein, M. and Azjen, I. (1975), *Belief, Attitude, Intention and Behavior: An Introduction to Theory and Research*. Reading, MA: Addison Wesley.

Fowler, J. (2004), "WHO sees Polio Outbreak for Africa", *The Associated Press/Birmingham News,* June 23, p.6D.

Gallivan, M. J., (2001), "Organizational Adoption and Assimilation of Complex Technological Innovations: Development and Application of a New Framework," *Database for Advances in Information Systems*, summer 2001, (35)3, pp. 51-85.

Gefen, D., Karahanna, E., and Straub, D., (2003). "Trust and TAM in Online Shopping: An Integrated Model"*. MIS Quarterly,* (27)1, March,pp. 51-90.

Gefen, D., and Straub, D. (1997), "Gender Difference in the Perception and Use of E-Mail: An Extension to the Technology Acceptance Model", *MIS Quarterly,* (21)4, December, pp.389-400.

Grover, V., and Ramanlal, P. (1999), "Six Myths of Information and Markets: Information Technology Networks, Electronic Commerce and the Battle for Consumer Surplus", *MIS Quarterly,* (23)4, 465-495.

ITU (International Telecommunications Union), 2004, http://www.itu.int/itudoc/itu-t/com3/focus/72404.html and http://www.itu.int/itunews/issue/2001/02/ indicat.html

Jensen, M., (2001), "The African Internet – A Status Report", http://www3.wn.apc.org/africa/afstat.htm

Madon, S. (1997), "Information-Based Global Economy and Socio-Economic Development: The Case of Bangalore," *The Information Society,* (13), pp. 227-243.

Madon, S. (2000), "The Internet and Socio-Economic Development: Exploring the Interactions," *Information Technology and People,* (13)2, pp. 85-101.

Malhotra, Y., and Galletta, D.F., (1999), "Extending the Technology Acceptance Model to Account for Social Influence: Theoretical Bases and Empirical Validation", *Proceedings of Hawaii International Conference on Systems Sciences* (HICCS).

Mathieson, K., Peacock, E., and Chin, W., (2001), "Extending the Technology Acceptance Model: The Influence of Perceived User Resources," *Database for Advances in Information Systems*, (32)3, pp. 86 – 112.

Mbarika, V., Musa, P. F., Byrd, T. A., and McMullen, P. (2002), "Teledensity Growth Constraints and Strategies for Africa's LDCs: "Viagra" Prescriptions or Sustainable Development Strategies?," *Journal of Global Information Technology Management,* (5)1.

Meso, P., and Duncan, N., (2000), "Can National Information Infrastructures Enhance Social Development in the Least Developed Countries?: An Empirical Investigation," *Journal of Global Information Management,* 8(4), pp. 30-43.

Meso, P., Musa, P., and Mbarika, V., (2005), "Towards a Model of Consumer Use of Mobile Information and Communication Technology in Sub-Saharan Africa: A Case of Kenya and Nigeria", Information Systems Journal, Vol. 15, Issue 2, pp. 119-146.

Morales-Gómez, D., and Melesse, M (1998), "Utilizing Information and Communication Technologies for Development: The Social Dimensions," *Information Technology for Development,* (8)1, pp. 3-13.

Motorola (2003), Mobile Explosion. http://www.motorola.co.za/about/press_releases/2003/jun/explosion.aspx, June, Retrieved May 2004.

Myers, W. (1997), "Measuring Assets in the Information Age," *IEEE Software*, (14)1, pp. 89 – 90, January

Odedra-Straub, M., ed. (1996), *Global Information Technology and Socio-economic Development*. Nashua, NH: Ivy League

Odunfa, A. (2003). Security breaches in Corporate Nigeria. http://www.uknigeriabusinesses.com/articles/security_nigeria.htm, Retrieved May 2004.

Oyelaran-Oyeyinka, B., and Adeya, C. N., (2002) *Internet Access in Africa: An Empirical Exploration*, Netherlands: United Nations University Institute for New Technologies.

Panos Institute, The (1998), *The Internet and Poverty: Real Help or Real Hype?*, London: The Panos Institute.

Ross, E. (2004), "UN Report: World Losing Race Against Aids", *The Associated Press/Birmingham News*, July 7, p.4A.

Sankar, Chetan S. (1994), "The Expert's Opinion: an Interview with Sam Pitroda, Advisor to the Prime Minister on Technology Missions, Republic of India", *Journal of Global Information Management*; (2)1,Spring

Sein, M. K. and Harindranath, G.,(2004), "Conceptualizing the ICT Artifact: Towards Understanding the role of ICT in National Development", *The Information Society*, (20)1 pp. 15-24

Sahay, S., and Avgerou, C., (2002), "Introducing the Special Issue on Information and Communication Technologies in Developing Countries", *The Information Society*, (18)2, pp. 73-76

UNDP (United Nations Development Program), *Human Development Report 2001: Making New Technologies work for Human Development*, New York: Oxford University Press

Venkatesh, V. and Morris, G., (2000), "Why Don't Men Ever Stop to Ask for Directions?: Gender, Social Influence, and Their Role in Technology Acceptance and Usage Behavior," *MIS Quarterly*, (24)1, pp. 115-139

World Almanac and Book of Facts, (2003).

World Development Indicators Database (2004), Washington DC: World Bank.

APPENDIX I: THE 43 COUNTRIES OF SUB-SAHARAN AFRICA

The 43 Countries that make up Sub-Saharan Africa

Angola	Cote de'Ivoire	Liberia	Senegal
Benin	Djibouti	Madagascar	Sierra Leone
Botswana	Eritrea	Malawi	Somalia
Burkina Faso	Ethiopia	Mali	South Africa
Burundi	Gabon	Mauritania	Swaziland
Cameroon	Gambia	Mauritius	Tanzania
Central African Republic	Ghana	Mozambique	Togo
Chad	Guinea	Namibia	Uganda
Comoros	Guinea Bissau	Niger	Zambia
Congo	Kenya	Nigeria	Zimbabwe
Congo DR	Lesotho	Rwanda	

Source: Environmental Information Systems in Sub-Saharan Africa. http://www.grida.no/eis-ssa/. (Accessed April, 2005).

ABOUT THE AUTHORS

Philip F. Musa is Assistant Professor of Management and Information Systems in the School of Business at The University of Alabama at Birmingham. He holds a B.S.E.E., M.S.E.E., M.B.A., and Ph.D., all from Texas Tech University. His published research on information technology in developing countries appears in such journals as the *Journal of Global Information Management*, *Communications of the ACM, Electronic Journal of Information Systems in Developing Countries,* and *Information Systems Journal*. He presented and published in proceedings of national and international information systems conferences such as Americas Conference on Information Systems, the International Federation for Information Processing, Information Resource Management Association, Global Information Technology Management, among others. Dr. Musa is a senior member of the Institute of Electrical and Electronics Engineers (IEEE), and a member of the Association of Information Systems (AIS), and a lifetime member of Phi Kappa Phi. He is a licensed professional engineer with background in the semiconductor industry.

Peter N. Meso is Assistant Professor of Information Systems at Georgia State University. His PhD degree in Information Systems is from Kent State University. He holds a Bachelor of Science (Information Systems) and an MBA degree from the United States International University – Africa. His work on information systems in developing nations appears in the *Communications of the ACM, Journal of Global Information Management*, *Information Systems Journal*, *Electronic Journal of Information Systems in Developing Countries*, among others. Dr. Meso is also interested in software engineering and its implications on knowledge management, where his works appear in the *Journal of Systems and Software*, the *Journal of Knowledge Management, and the Journal of Information Systems Education.* In additiony, he presented and published in proceedings of many information systems conferences, including International Conference on Information Systems, Americas Conference on Information Systems, and the International Federation for Information Processing.

Victor W. Mbarika is on the faculty in the College of Business at Southern University and A&M College. He holds a B.S. in Management Information Systems from the U.S. International University, a M.S. in MIS from the University of Illinois at Chicago, and a Ph.D. in MIS from Auburn University. His research on information and communications technology (ICT) diffusion in developing countries and his research on multimedia learning are published (or are forthcoming) in 22 academic journals, four book chapters, and over 40 national and international conference publications on information systems. Dr. Mbarika is Founder of the Cameroon Computer and Network Center (CCNC). He is a member of the Association of Information Systems (AIS), the Institute of Electrical and Electronics Engineers (IEEE), and the Information Resources Management Association (IRMA).

Communications of the Association for Information Systems

ISSN: 1529-3181