Journal of the Association for Information Systems
IS RESEARCH PERSPECTIVES ARTICLE

The Neglected Continent of IS Research: A Research Agenda for Sub-Saharan Africa*

Victor W. A. Mbarika
College of Business
Southern University and A&M College
victor@mbarika.com

Chitu Okoli
John Molson School of Business
Concordia University
Chitu.Okoli@concordia.ca

Terry Anthony Byrd
College of Business
Auburn University
tbyrd@business.auburn.edu

Pratim Datta
Department of Information Systems
Washington State University
pdatta@wsu.edu

Abstract

Research with a focus on Sub-Saharan Africa (SSA), a major region within the world's second largest continent, is almost non-existent in mainstream information systems research. Although infrastructures for information and communication technology (ICT) are well established in the more developed and industrialized parts of the world, the same is not true for developing countries. Research on developing countries has been rare in mainstream IS and, even where existent, has often overlooked the particular situation of SSA, home to 33 of the world's 48 least-developed countries. Ironically, it is such parts of the world that can stand to gain the most from the promise of ICT with applications that would help the socioeconomic development of this region. In this study, we present the need for focused research on the ICT development and application for SSA. The information systems research community has a unique and valuable perspective to bring to the challenges this region faces in developing its ICT infrastructure,

* Detmar Straub was the accepting senior editor for this paper.

hence extending research and practice in ICT diffusion and policy. We present here a research agenda for studying the adoption, development, and application of ICT in SSA. In particular, teledensity, telemedicine, online education, and e-commerce present important areas for research, with implications for research, practice, and teaching.

Keywords: Sub-Saharan Africa, telecommunications infrastructure, information and communication technologies (ICT), ICT development, ICT application, telemedicine, online education, electronic commerce, information systems research, ICT diffusion, socioeconomic development

Introduction

In his letter of introduction as president of the Association for Information Systems (AIS) for 2002-2003, Philip Ein-Dor commented:

> AIS did not cause the digital divide, but it is certainly very much a reflection of it. A few numbers may highlight this. Region 2 comprises Europe, Africa and the Middle East. There are 287 members with Region 2 e-mail addresses. Of these, only 17 are in the Middle East and 19 in all of Africa. If we subtract 15 members in South Africa, there are just 4 members in all the rest of Africa! This compares with 31 members in Germany and 72 in the UK alone. (2002)

Ein-Dor's comments strikingly highlight the under-representation of African researchers in the world's premier academy of information systems (IS) researchers. It is somewhat surprising that this region of 633 million people—10% of the world's population—is so neglected in the important contemporary domain of IS research. Sub-Saharan Africa (SSA), a major part of the world's second largest continent, is the region with the lowest level of technological development in the world. The importance of low ICT development in SSA, also the economically poorest region in the world, is that considerable research has shown that ICT is a key for economic growth and development in virtually all countries in the present information age (Dutta, 1997; Dutta, 2001; Gilbert, 1996; Jensen, 1999; Mbarika et al., 2001; Meso and Duncan, 2000; Odedra et al., 1993; Odedra-Straub, 1993; Petrazzini and Kibati, 1999; Press, 1999; Raman and Yap, 1996; Salem, 1986; Splettstoesser and Towry-Coker, 1999; Wolcott et al., 2001).

With the development of complex and modern ICT, both developed and underdeveloped countries are exploring ways to enjoy the many benefits of these technologies (Dutta, 2001; 2002; Goodman, 1994; Mbarika, Byrd, and Raymond, 2002b; Straub, Loch, and Hill, 2001). Sadly, however, a digital divide between developed countries and underdeveloped countries looms large. The digital divide is defined as the "differential capabilities of entire social [or regional] groups to access and utilize electronic forms of knowledge" (Straub, 2003 p. W477), segregating the "haves" from the "have-nots" in the information society. While much discussion on the digital divide has focused on that which occurs among different social groups within a single country (Hoffman and Novak, 1998), we note here the international digital divide between different countries (Straub, 2003). This digital divide is abundantly clear when comparing ICT in SSA with the countries of the West like the United States or the United Kingdom. For example, while the US and the UK have been enjoying Internet connectivity for more than two decades, Eritrea had its first Internet connection only in 2000. Similarly, and closely related, while the US boasts more than 60 telephone lines per 100 people, many SSA countries still share less than 1

line per 100 people. The use of ICT in SSA also lags considerably even when compared to other underdeveloped regions, such as those in Central America.

The region we call SSA in this paper consists of 49 countries that, along with their 633 million people, have some of the fastest growing populations in the world. These countries are demarcated by their geographical location. A map is shown in Appendix A. SSA begins immediately south of the Sahara Desert below the Tropic of Cancer (latitude 23½° N) through the Equator down to 35° South, just north of South Africa. North Africa is not included in this region, as it resembles the Middle East much more than the rest of Africa. South Africa is not included in this present study because of its confounding socioeconomic situation, where Western European influences are much stronger than in the rest of the region. The table in Appendix B shows the disparity when comparing North and South African countries to SSA countries.

The countries of SSA are typically low-income nations suffering from long-term constraints against growth. These constraints include low levels of human resource development and severe structural social, political, and economic weaknesses (Austin, 1990). However, SSA has a scarred history, exploited and ravaged both from within and beyond. After a long and grim colonial period, the region plummeted into subsequent crises in governance, economy, and healthcare. More than 8 million people in SSA have been victims of civil wars and tribal feuds over the past few decades. More than 40% of the population is illiterate, with reported gross domestic products amounting to less than $1 a day for more than 50% of citizens. HIV infection has grown to epidemic proportions, with 70% of the world's HIV cases occurring in SSA. From a technological standpoint, SSA represents the least developed region of the world in terms of telecommunications infrastructure development (Mbarika, 2001; Odedra et al., 1993). As a result of these problems, it is home to 33 of the 48 least-developed countries (LDCs) of the world (OHRLLS, 2003). These dismal statistics are but a sample of the many afflictions plaguing the region and necessitating immediate intervention. In this paper, we are not addressing the reasons why SSA countries are in their present condition, but rather we focus on how the IS research community can contribute to alleviating some of the ills of SSA.

Most of the theoretical frameworks that have been reported in the top IS journals like *MIS Quarterly (MISQ)*, *Information Systems Research (ISR)*, *Journal of MIS (JMIS)*, and *Journal of the AIS (JAIS)* are based on ICT research that has been completed in Western countries like the United States and England. SSA is highly tribally segregated, offering a rich variety of languages, social mores, and cultures. The cultural, political, social, and economic uniqueness that SSA presents could provide researchers with fertile ground for fresh extensions of existing theoretical paradigms and sometimes entirely new and different research frameworks. Because of their uniqueness, the cultural, political, social, and economic traits are likely to moderate the relationship between ICT investments and performance outcomes differently from in Western countries, or even in the more "developed" developing countries. Using these traits as moderators in research projects on ICT in SSA will almost assuredly force changes in the underlying theoretical frameworks on which these projects are based. Such research projects could provide researchers and practitioners a rich and insightful template of fundamental IS applications and offer potential tentative generalizations for developing nations. This paper attempts to set a research agenda for IS researchers who are interested in doing research in SSA. We review several ICT research areas through the lenses of the cultural, political, social, and economic traits of SSA countries. Specifically, we develop and examine an ICT ecosystem for SSA and explore the research implications using these traits. In many ways, at least economically, Sub-Saharan Africa offers the polar opposite end of the spectrum in terms of

diversity of research setting, thus offering an opportunity to test the limits of generalizability of many theories.

Development researchers have hailed new ICT as the "great equalizer", revolutionary technological tools that can enable efficient transfer of information on a global scale (Brynjolfsson and Smith, 2000; Travica, 2002). This global information can be used for international trade (UNECA, 1999c), online digital libraries (Rosenberg, 1998; Rosenberg, 1999), online education (Light, 1999), telemedicine (Mbarika, 2003), e-government (Becker, 2001), and many other applications that can potentially solve critical problems in the developing world. These applications could help push SSA up the economic ladder and possibly make it a critical trade partner in the international community. Because of the great schism between ICT infrastructures in SSA and many other countries of the world, it is critical that modern technological infrastructures be initiated, developed, diffused, and routinized in SSA. Otherwise, SSA may be permanently excluded from the technological community and, thus, the economic community in the world markets.

Although the SSA region holds much promise because of its natural and other resources, solutions must be found to its technological problems in order for its economic destiny to change. IS researchers can be an instrumental component in helping to solve problems associated with the implementation of new ICT infrastructures. Developed countries take for granted sources of widespread public information such as television broadcasting, telephone services, educational institutions, and public libraries. In developing countries, however, such infrastructure is seriously deficient, and this cripples citizens' ability to gather information and coordinate with each other to solve their problems (Odedra-Straub, 1993). Through efficient information dissemination, ICT infrastructures promise a quantum-leap boost in internal communications in developing countries. Previous research argues specifically that such infrastructures are fundamental to the socioeconomic development of developing countries within the SSA region (Chifwepa, 1996; Mbarika, 2001; Odedra et al., 1993; Odedra-Straub, 1993). The Vice President of Finance and Private Sector Development of the World Bank noted, "Low-cost telecommunications and information systems are simply not luxuries for developing countries in today's world. On the contrary, they are strategic factors of production central to the development process and to poverty reduction" (Rischard, 1996).

Based on the positive impact of ICT in the most technologically-advanced nations, leaders from both developed and developing nations have increasingly realized that ICT infrastructure development is vital for the socioeconomic well-being of developing nations. In a plea at the World Summit on the Information Society, the United Nations Secretary General Kofi Annan (2003) called for the U.S. information community to involve its innovative dynamism to bridge the digital divide that threatens to marginalize development prospects. The UN has approved $6 million for the "Internet Initiative" in Africa and a further $11.5 million for ICT projects under the banner of "Harnessing Information Technology for Development." The Africa Growth and Opportunity Act is a step in that direction, triggering the creation of 190,000 jobs and investments of $340 million within three years of its inception. Foreign direct investments have jumped from less than $1 billion in 1995 to $7.2 billion in 2003 (USAID, 2003). Referring to SSA as the "last great emerging market of the world," President George W. Bush, in his July 2003 trip to Africa, committed to a "trade not aid" policy. In a resolution to help developing countries take full advantage of the Internet, the G-8 members (Britain, Canada, France, Germany, Italy, Japan, Russia, and the United States) declared: "Countries that succeed in harnessing information (and communications) technology potential can look forward to leapfrogging conventional obstacles of infrastructure development," and, "Everyone should be able to enjoy access to information and communications networks" (CNN, 2000). Such access could be an

impetus to bridge the digital divide between the developed countries and developing countries such as those in SSA. In 1987, Felix Houphouet Boigny, the former President of Ivory Coast, warned, “since Africa missed the Industrial Revolution, we can’t afford to stand aside and let the communication revolution go by too” (Rahedi, 2002 p. 19).

The marked disparity between SSA, an underdog, and other world regions adds credibility and relevance to our research focus in tying together the region’s ICT infrastructure to its consequent socioeconomic betterment. We, as a community of IS researchers, are arguing for these underdogs, contending that access to information is a prerequisite to sustainable development. Take for example IDRC’s (International Development Research Centre) ICT project called Acacia, and its impact on Senegal’s villages (IDRC, 2002a). Acacia introduced the Internet to rural villages in Senegal to improve information accessibility. The results have been dramatic. Local elected representatives can access the latest land reform legislations and inform themselves on natural resource management. Local health officials are looking up information for diagnostic assistance and preventative medicine, as well as using ICT to maintain medical inventories. Peasants are learning about weather forecasts, land reform initiatives, and funding options. The informating of rural Senegal provides a glimpse of how the power of information can be harnessed for considerable impact on the environment and for social spillover benefits. Because of this relationship between ICT and its socioeconomic environments, we use the “information ecosystem” metaphor to bring ICT to the forefront and to visualize their intrinsic environmental benefits as a single encompassing system.

Even the private sector has moved in. Sun Microsystems, AOL Time-Warner, and HP have pledged $10 million toward using information to better the quality of life in SSA (Kowalczykowski, 2002). At the center of it all is the belief that only access to information can allow SSA to leap-frog its way to become a participant, rather than an onlooker, in the information society. From the World Bank to HP, there is a unanimous recognition that information systems can lead to improved governance, better management of human capital (including education, healthcare), a more congenial institutional climate for investment, and further debt reduction and development assistance. As Odedra et al. (1993) note, the need for an information ecosystem for SSA is not presumptuous, but rather a precursor that can usher in a new era of growth and opportunity. Maintaining that SSA needs to assess its technological needs before taking a leap of faith by looking toward the western world, Odedra et al. (Odedra et al.) contend that a prudent choice of technology, along with a focused infrastructure development, is the key to overcoming the odds that have plagued SSA over decades. In this vein, proposing an ICT ecosystem for SSA seems a logical and actionable approach to uplift the region from being a technological desert.

Using the contexts of the countries of SSA and their distinctive cultural, social, political, and economic characteristics in ICT research may force a change in the research paradigms that have been reported in our top IS journals. A shift in many of these paradigms themselves could serve as a compelling incentive for researchers, allowing them to uncover, revisit, and operationalize constructs anew. At the very least, we may discover a clear distinction between the development, use, and implementation of ICT in the least developed countries, under-developed countries, and more developed Western nations.

SSA Research in Key Information Systems Journals

We searched a number of key information systems journals for publications concerning Sub-Saharan Africa. This is not by any means meant to be a comprehensive survey of IS research on SSA (for such reviews, see Okoli (2003), Okoli and Mbarika (2003), and Mbarika (Mbarika,

2001)), but by selecting a few important journals, we can get a rough idea of the highest caliber of information systems research that has focused on this part of the world to date. Based on the Lowry et al. (2004) extremely comprehensive ranking of IS journals, we selected the three top-ranked journals dedicated to research in IS: *MISQ*, *ISR*, and *JMIS*. These are widely acknowledged as the premier journals in information systems, representing the highest quality of research that is carried out in this field. Vessey, Ramesh, and Glass (2002) empirically analyzed the nature of publications in five leading IS and decision sciences journals from 1995 to 1999. In this representative period, the three leading IS journals mostly published research at the organizational and individual levels of analysis. *ISR* and *JMIS* had nine and four articles, respectively, at the societal level of analysis, which would be very applicable to much of the research we propose in this agenda for SSA; *MISQ*, being dedicated to organizational research (Zmud, 1995), avowedly does not publish such articles. All three journals published a few articles on societal concepts *(ISR,* three; *JMIS,* three; and *MISQ,* two). Nearly half the articles in the three journals adopted a positivist research approach, albeit they all published several interpretive studies, as well as other research approaches, such as those that focused more on description or model formulation.

We also searched the *Journal of the AIS* (*JAIS*)—the flagship journal of the Association for Information Systems—and the *Communications of the AIS* (*CAIS*)—the Association's general-interest journal. These two journals have an explicit goal to be innovative and creative—including embracing unconventional as well as general themes that encompass the full breadth of the information systems discipline. Out of 1,833 research articles published in these five journals, as of April 2004, we found only one article (in *JMIS*) related to SSA (de Vreede, Jones, and Mgaya, 1999). This sole top-journal publication used a grounded theory approach to develop a cultural model based on the Technology Acceptance Model of how group support systems are accepted in East and Central Africa. In a field study of 11 projects in three countries, de Vreede et al. (1999) found that, while the high power distance of East African culture did not stop managers from using groupware, they did neglect some of the democratic decision-making features of the software in order to retain their authority when they deemed it necessary.

Table 1 presents a listing of SSA-related research publications in key information systems journals, including three other journals that were developed specifically to cover global IS research: *Journal of Global Information Management* (*JGIM*), the *Journal of Global Information Technology Management* (*JGITM*), and the *Electronic Journal on Information Systems in Developing Countries* (*EJISDC*). These three additional journals already have a history of publishing such research, as Table 1 illustrates. The articles that these journals accept span all levels of analysis, methodological approaches, and topic areas (within their stated scopes of global IS or IS in developing countries).

There may be several reasons to explain this deficiency in these five leading journals. Perhaps many of the studies that focused on the SSA region did not carry the level of rigor and relevance required. Perhaps scholars in the developed world find it difficult to venture into research based on a part of the world they neither have visited nor intend to visit. Moreover, scholars that reside within the SSA region do not seem to be active in mainstream information systems arenas due to several reasons such as lack of financial incentives to do research. Relative to the distinctively different "research" and "teaching" universities in North America, most universities within the SSA region would be considered to be "teaching" institutions with very little pressure to publish in order to "survive" within their higher education sector. Therefore, very few scholars, even within the SSA region, are involved in research that focuses on this "forgotten" region of the world. From the perspective of the top IS journals, research with the society as the level of

analysis might not be so readily accepted as a meaningful contribution. Moreover, while they all do publish a few papers with societal topics, these do not seem to be core.

Table 1. Africa-Related Research Publications In Selected IS Journals

Journal	MISQ	ISR	JMIS	JAIS	CAIS	EJISDC	JGIM	JGITM
First Issue	**1977**	**1990**	**1984**	**2000**	**1999**	**2000**	**1993**	**1998**
# articles (Apr. 2004)	624	283	622	48	306	98	140	81
Sub-Saharan (except South Africa)	None	None	(de Vreede et al., 1999)	None	None	(Braa et al., 2001; Idowu, Alu, and Adagunodo, 2002; Mbarika, 2002; Mbarika et al., 2003; Mbile, DeGrande, and Okon, 2003; Soriyan et al., 2001; Splettstoesser and Kimaro, 2000; Yavwa and Kritzinger, 2001)	(Odedra-Straub, 1993) (Mbarika et al., 2002b) (Hasan and Ditsa, 1999; Wresch, 2003)	(Splettstoesser and Towry-Coker, 1999) (Mursu et al., 1999) (Darley, 2001) (Okunoye and Karsten, 2002) (Brown and Licker, 2003; Mbarika et al., 2002a; Okoli and Mbarika, 2003)
South African	(Miller and Doyle, 1987; Money, Tromp, and Wegner, 1988)					(Brown, 2002; Cloete, Courtney, and Fintz, 2002; Fleming, 2002; Licker, 2001; Mbarika et al., 2003)	(Karlsbjerg, Damsgaard, and Scheepers, 2003)	(Erwin and Blewett, 1999)
North African	(Nidumolu et al., 1996)					(Chandani and Breton, 2001; Mbarika et al., 2003)	(Hill et al., 1998; Kamel, 1995; Khalil and Elkordy, 1997; Rose and Straub, 1998; Straub et al., 2002; Straub et al., 2001)	
Total African	**3**	**None**	**1**	**None**	**None**	**13**	**11**	**8**

Key to Table 1

Journals	
MISQ	MIS Quarterly
ISR	Information Systems Research
JMIS	Journal of Management Information Systems
CAIS	Communications of the AIS
JAIS	Journal of the AIS
EJISDC	Electronic Journal on Information Systems in Developing Countries
JGIM	Journal of Global Information Management
JGITM	Journal of Global Information Technology Management

Having explained the need for a research program such as we call for in this paper, the following section presents a framework for an information ecosystem in SSA that can serve as a guide for research on ICT in this region. Subsequent sections discuss different aspects of this

infrastructure in detail, highlighting their potential for research in ICT issues in SSA. In particular, we examine teledensity as a means of adopting ICT; ICT development; and telemedicine, online education, and e-commerce as socioeconomic applications of the information ecosystem. After these overviews we list suggested research questions that would give important new insight into these areas, and then we follow with implications.

An Information Ecosystem Framework for Sub-Saharan Africa

Worldwide ICT investments, currently billed at about $1.2 trillion and expected to rise by 8-10% in the next few years (IDRC, 2002b) are overtaking global economic growth. This is evidence that technological investments are assuming a leading role in the development of global economies. However, harnessing the power of such investments is dependent upon a multitude of interrelated and interacting factors that work together to define the ICT ecosystem. The factors include precursors, mediators, moderators, and outcomes fueled by ICT investments. Based on several models for national ICT (Meso and Duncan, 2000; Wolcott et al., 2001), we present here an ICT ecosystem model for Sub-Saharan Africa that can serve as a high-level research framework (Figure 1).

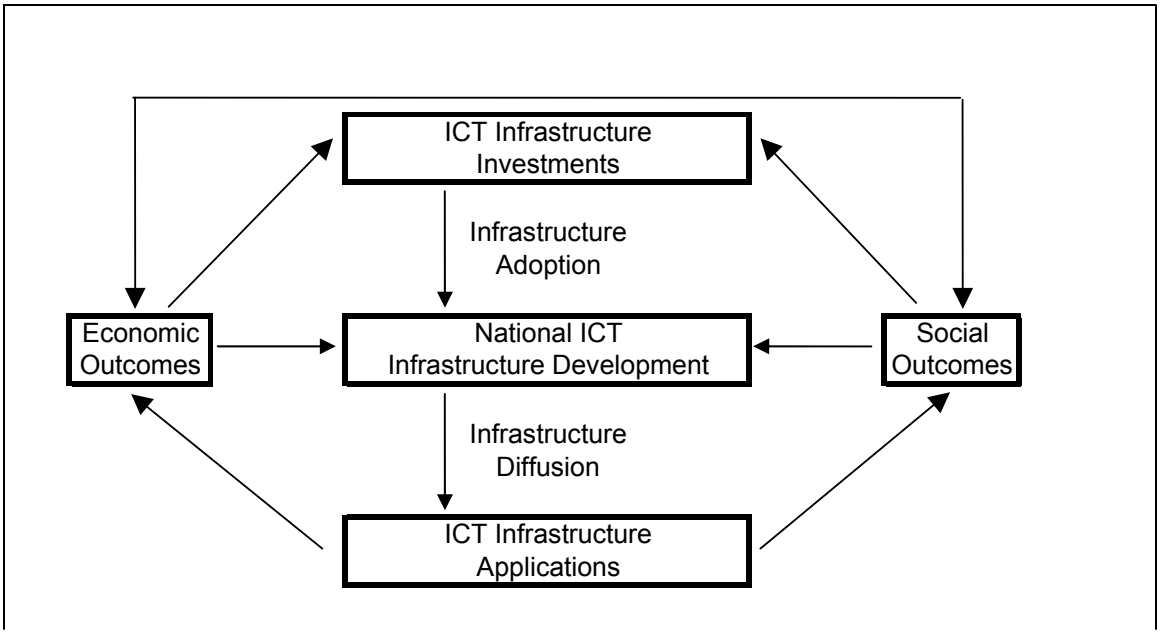

Figure 1. An ICT Ecosystem for Sub-Saharan Africa

As mentioned earlier, the ICT ecosystem for SSA is examined as a community of pertinent and cohesive factors within the SSA environment, functioning as a unit. The framework of the ICT ecosystem is developed as a complex relationship including infrastructure investments, infrastructure development, and infrastructure applications that lead to social and economic outcomes, which further affect both infrastructure investments and infrastructure development. In addition to the recursive relationship between the outcomes and infrastructure investments and infrastructure development, the two outcome dimensions (social and economic) are mutually related.

According to the resource-based view of the firm (Barney, 1997), socioeconomic differentiation is achievable when individual economies manage "unique" and difficult-to-use resources. Resources can be tangible (e.g. financial and physical assets), intangible (e.g. asset quality), or personnel-based (e.g. asset support and management skills) (Grant, 1991). These resources are difficult to imitate in their combination, which makes them unique in their use. According to Bharadwaj (2000), ICT resources serve as basic units of analysis to create differential advantage by their assemblage, integration, and deployment to create capabilities.

Our proposed framework begins with ICT infrastructure investments, commonly prompted by capital outlays. Once the investments are in place, the challenge becomes a matter of translating the investments into resources that can provide rents to an economy. However, translating investments into resources is contingent upon the degree of infrastructure adoption and governance. Infrastructure development theories provide a glimpse into the preconditions and contingencies of developing infrastructure resources. For example, Cogburn's (2003) study of how regimes are transformed to cater to emergent ICT trends is indicative of governance structures in both developing and developed countries. Governance has to cater to institutional pressures (Shirley, 1999) and diverse stakeholders (Cogburn, 2003), and is sometimes forced to sway to accommodate dominant stakeholders. Such scenarios abound in SSA where particular investors can sway governance regimes.

However, if able to combine strategically, the countries of SSA can harness their tangible, intangible, and personnel resources to offer unique resource capabilities. To elaborate, SSA is trying to emerge as an economy built upon a regional alliance of more than forty countries. Together, they have the ability to wield a collective resource potential. In other words, resources are basic inputs; it is the socioeconomic differentiation that can yield distinct resource outcomes from internal resource combinations. In the context of SSA, regimes and institutional influences make the combination of these resources unique and inimitable. Economic proposals in SSA such as the Growth and Opportunity Act, along with institutional pressures from emerging peer-reviewed governance, have increased transparency, and the development of objective ICT policies allowing for the pooling of resources. Supportive regimes (national and international) and economic and policy restructuring, especially in relation to ICTs, can streamline governance and facilitate cooperative decision making in SSA (Cogburn, 2003).

While resources in SSA are ill-developed, proper governance mechanisms can harness them for innovative application and use, guided by social and regional culture. For example, cellular and satellite networks are gaining popularity as surrogates for fixed landlines that lack maintenance and are often severed during conflicts. Cellular and satellite networks are becoming the media of choice for delivering local, regional, and international content. In SSA, regimes and institutions are slowly organizing resources (tangible, intangible, and personnel) with an eye on local and global needs, changing the way people "live, work, and play." Together, emerging regimes and institutional forces in SSA can allow collective pooling of resources and collective bargaining power, thus creating unique resource combinations that are difficult to imitate.

In terms of ICT development,tangible, intangible, and personnel resources can work in combination to provide a degree of inimitability. Once ICT resources are developed, countries must primarily focus on developing "capabilities" for the diffusion of such resources. Bharadwaj (2000 p. 171) defines capabilities as the "ability to mobilize and deploy [ICT] resources in combination or co-present with other resources." The mobilization of resources is thus contingent upon how effectively infrastructure resources are diffused through application. A lack of capabilities has been the unfortunate case in SSA. Unplanned ICT investments have led to a

predominance of standalone PC systems with no network or LAN access. Among them, PC users in a workplace might compete for only one or two that are connected to the Public Switched Telephone Network using modems, leading to severe underutilization of the rest.

Most SSA countries have only lately understood that application and use of existing ICT is a prerequisite to the diffusion of information. Fidonet in Africa serves as a prime example. Fidonet grew as a bulletin board, "store and forward" system running on PCs using dial-up lines and legacy systems for exchanging email, files, and news briefs. It was from the Fidonet gateway that the South African UNINET-ZA, Worknet/Sangonet evolved as one of the early academic networks using this "low-cost," "low-tech" approach (Thapisa, 1996). Unfortunately, few such applications have emerged. In an attempt to blindly emulate the west, SSA has capitulated to acquiring technology while lacking the capability to apply technology in solving real problems. IT policies or strategic buying plans that are necessary to relate IT acquisition to socioeconomic benefits are generally non-existent (Odedra et al., 1993). Unable to utilize or mobilize existing infrastructure resources, SSA seems to be caught in a "scarce-knowledge trap" (Thapisa, 1996). As Odedra et al. (1993 p. 28) had rightly remarked, "At present, the most pressing need in SSA is not new systems, but rather the know-how to effectively use what is already there."

However, mobilizing existing resources requires a strategic assessment of their potential benefits. For SSA, such an assessment lies at the core of developing ICT capabilities and escaping the "scarce-knowledge trap." The proposed information ecosystem framework (Figure 1) addresses that very issue in the context of SSA and other LDCs. The common threads that bind SSA and other LDCs are based on the underutilization of ICT, lack of prudent investments, problematic governance, and failure to develop and apply ICT for socioeconomic growth. This ecosystem for SSA provides a cohesive representation of ICT together with salient socioeconomic consequences

The ecosystem framework begins with ICT investments, intended toward the acquisition of infrastructure, mainly in the form of gross national technology budgets. Once capital is committed to ICT, national technology strategies must drive infrastructure adoption; that is, they must determine strategic infrastructure priorities for developmental objectives. Strategic directives set the course for ICT policies that come into play in infrastructure development. In this stage, SSA must rely on the involvement of a critical mass of users as well as development and support personnel for the adopted infrastructure. With the requisite number of users and support and maintenance personnel, SSA must then take measures to diffuse the infrastructure for newer and more innovative applications. In the context of SSA, infrastructure application needs to be directed toward specific socioeconomic objectives. Social development must look toward outcomes such as telemedicine and online education. Similarly, economic development objectives must emphasize objectives such as electronic commerce. These socioeconomic outcomes derived from the application of ICT resources will then affect future investment considerations and future infrastructure development. Furthermore, social and economic outcomes both affect each other. For example, increasing awareness about, and the use of, telemedicine may prompt the growth of ancillary telemedicine industries. Similarly, electronic commerce may help increase access and use of telemedicine and online education by using the Internet as a conduit, thus narrowing the digital divide. The information ecosystem framework sets up a cohesive partnering of investments, development, application, and socioeconomic growth. For SSA, understanding the ecosystem would be a first step toward any concerted socioeconomic initiative.

With an ICT ecosystem as a guiding framework for researching the impacts and potential of ICTs in SSA, we now proceed to discuss each of the underlying dimensions of the framework.

We discuss the important role played by each of these dimensions and identify some of the important research issues that surface. We begin by understanding how ICT is initially adopted, specifically through ICT investments aimed at increasing teledensity, and then by examining how these investments can be converted to tangible and intangible national ICT assets. The subsequent sections then examine some important social and economic applications of ICT resources, specifically, telemedicine, online education, and e-commerce.

ICT Infrastructure Investments, Adoption, and Development

Colonial rule in SSA allowed occupying countries to install telecommunications infrastructures to serve their ad-hoc administrative needs. Post-colonial rule was an exercise in conflict, prompting world powers to make decisions through aid efforts and developmental advice. Influenced by expatriate consultants, SSA has embarked on a perilous attempt to mimic the Western world in its ICT initiatives. Computerization has been a function of the multi-national expatriate community, aid agencies, or blind acquisition. According to Odedra et al. (1993), in the mid 1980s, more than 50% of Africa's computer installations were donated, and the percentage in SSA alone was considerably higher. Other installations have been leftovers from expatriate projects. The rest have been pushed by vendors who have found SSA an attractive market where questions about ICT concern the latest design, rather than the sophistication of use. Many times the countries of SSA have seen ICT handed to them free of cost, with little instruction on their operation and effective use. Foreign aid has not only forced SSA to unconditionally accept what is given, but also complicates the situation by failing to provide training or support while bearing the recurrent costs of equipment maintenance, all of which cost money. To make matters worse, the implementations of ICT are generally tied to donor countries, implicating additional capital provisions for future maintenance, support, and consulting (Odedra et al., 1993). The findings unanimously point toward a total failure in technology transfer, leading to ICT dumping rather than concerted adoption. As Odedra (1993 p. 43) laments,

> Many of the internationally well known manufacturers and suppliers that have set up shop in Africa are notorious for manipulating management and decision-makers into buying their equipment, providing very poor after-sales service, especially maintenance and training, and often providing obsolete technology. Their main concern is in selling "boxes" at inflated prices and not in transferring technology.

Consequently, SSA, already afflicted with paltry ICT, suffers from serious underutilization of equipment. Such factors have contributed to questionable adoption practices, resulting in dismal teledensity statistics.

The lack of basic telecommunications infrastructure is a severe hindrance to the growth of the ICT in any country (Jensen, 1999). Previous research has associated the level of a country's basic telecommunications infrastructure with its teledensity (Mbarika et al., 2002b), defined as the number of land telephone lines per 100 people. While telephone lines have been traditionally used for voice communications, in virtually every country of the world, when the market sufficiently matured for such a need, they have eventually formed the national backbone of data telecommunications. Thus, teledensity remains an important indicator, if only a proxy, of national telecommunications infrastructure. For example, research on Latin America has identified low levels of teledensity as the main bottleneck for growth of ICT (Hunt, 1997; Pegasus Research, 2003; Wellenius, 1984). Although wireless telecommunications media such

as cellular telephony and VSAT are in the early adoption stage in SSA, research to date still views land line teledensity as a fundamental factor for ICT development.

SSA significantly lags behind other regions of the world in terms of teledensity, and with this disadvantage, the prospects of catching up with more developed countries in terms of ICT adoption look grim. While there are only 2.77 main telephone lines per 100 persons in all of Africa, there is less than one telephone line per 100 persons for most SSA countries (see Appendix B). These figures are substantially lower than even the 1998 figures of 7 per 100 in Asia, 10 in Latin America and the Caribbean, 37 in Europe, and 66 in the United States (UNECA, 1999a). Notwithstanding the fundamental role of teledensity for the SSA region, a focus to develop just the teledensity infrastructure will be a major mistake, given the rapid growth of wireless infrastructures; hence the need to re-visit the teledensity concept arises.

Although teledensity has traditionally only regarded land-based telephone lines, with the rapid adoption of wireless telecommunications media such as cellular telephony and VSAT, this concept will need to be expanded to include other measures of the state and extent of telecommunications infrastructure (Kibati and Krairit, 1999; Peha, 1999). SSA's size and topography makes landline installation and maintenance an expensive proposition. In contrast, wireless connections such as VSAT and cellular infrastructure are physically independent. Yet the research to date has almost exclusively employed the traditional measurement that considered only landlines. Traditional teledensity counts the number of landlines, whereas a contemporary calculation would consider each mobile telephone subscription to be a wireless "line." Appendix B lists the teledensities of all the countries in SSA, distinguishing between landline and mobile-phone teledensities. While SSA's landline teledensity doubled from 0.4 lines per 100 citizens in 1991 to 0.9 per 100 in 2002, the mobile teledensity shot from virtually zero in 1991 to 1.9 mobile phone subscriptions per 100 citizens in 2002. Many of these are digital connections, which pave the way for access to ICT in countries where most citizens cannot afford personal computers. In the future, it is likely that wireless communications will be more relevant than wired means for the development of SSA's data communications networks.

Even though most countries in Africa have established ICT networks, access is mostly restricted to the major cities, and it is quite expensive. In 1999, the average total cost of using a local dialup Internet account for 20 hours a month in Africa was about $68(US) per month. These costs include usage fees and local call telephone time, but not telephone line rental. When compared to SSA's 2002 per capita GDP of US$29 per month (compared to the United States' monthly per capita GDP of $3,019), it is obvious that personal Internet accounts are out of the reach for the vast majority of citizens. The monopolistic and parochial culture of telecommunication providers in Africa is reflected in the exorbitant tariffs charged in an age of diminishing costs (Adam, 1996). In addition, a considerable portion of African telephone switching is still done using analog equipment that makes it even more difficult to network digital traffic using computers. Furthermore, government-run telecommunication monopolies view telecommunications as a low priority issue only available to a select few, typically the urban "elite." Such restrictive practices have isolated a major part of the population (which is about 70% rural) from being able to access information. Misdirected telecommunication investments created an absurd situation where intra-African communications were routed via Europe, leading to transit charges in the hundreds of millions of dollars. In addition, restrictive regimes and practices have stifled emergent technologies, especially wireless telecommunications, making the issue even more acute in the case of Africa's vast rural population who remain captive to their inability to access information. Overtly regulated and covertly restrictive, information inequality is markedly high due to unscrupulous business practices and capricious public policy (Adam, 1996). This further contributes to high telephone, and by extension, high

Internet connection costs (Figure 2). While average access costs for SSA are approximately $55 for 20 hours per month, access costs in Western Europe and USA average approximately $20 for unlimited monthly use (ITU, 2001).

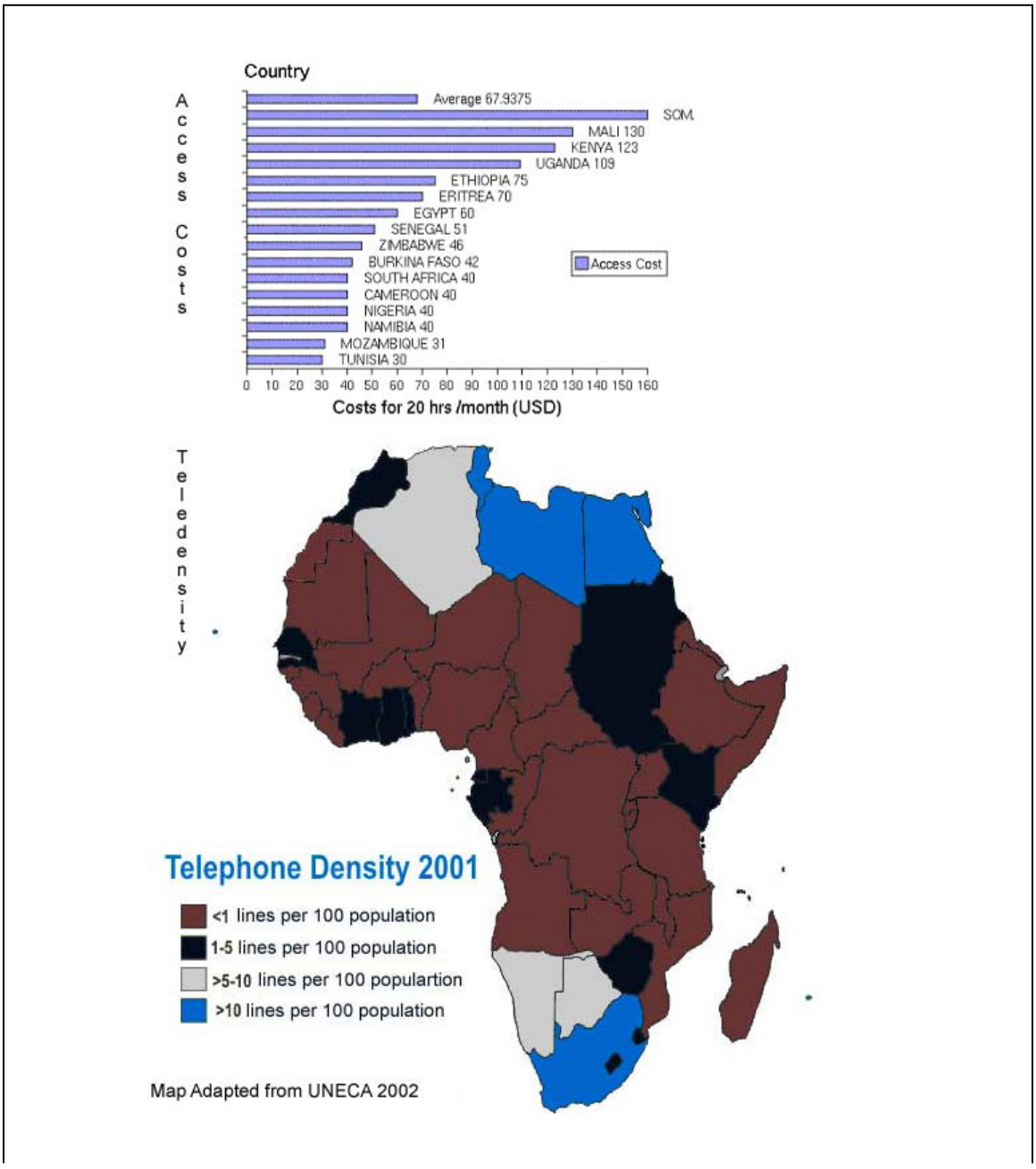

Figure 2. Dialup Access Costs And Teledensity In SSA

SSA has seen some potential ICT adoption problems because of capricious business venturing and restrictive governance. AT&T's Africa ONE high capacity undersea fiber optic cable was to encircle Africa and provide it with a high-speed backbone, but the project was rejected by landlocked countries that refused to cooperate, feeling that they would be left out of the development. The adoption of GMPCS (Global Mobile Personal Communication Systems) in

SSA also met strong resistance. GMPCS is a satellite-based communication system designed to use fewer infrastructure resources and service providers than other satellite systems. The idea of a single gateway to serve a region rather than a country would presumably be a welcome option for SSA. On the contrary, the lack of a domestic interconnection point infrastructure for communicating with the existing network was perceived as a regulatory impediment. As a result, an antipathy for the technology grew among SSA regulatory authorities, who equated the loss of country-specific licensing revenues with the loss of control. According to Adam (1996), governance problems that have impacted ICT adoption were related to a gamut of problems stemming from a distinct lack of coordination among SSA countries with equivocal ICT agendas to language barriers, unyielding monopolies, and obsolete regulatory practices. Altogether, this has resulted in disparate practices, with SSA countries working against each other rather than cooperating.

However, SSA is proactively questioning its governance patterns as it stands poised between development and decay. The drawing up of the New Partnership for Africa's Development, a peer review process aimed at improving governance and integration, has been welcomed as a step toward economic and political stability. Having overcome politics to a certain degree, Africa has been able to involve 36 telecommunications operators and various governments to help combine three telecommunications initiatives for increasing teledensity: the SAT3 cable between South Africa and Europe; the SAFE (South Africa Far East) cable between Africa and the Far East; and the West African Submarine Cable (WASC), in an attempt to link the whole of Africa. Such bold steps are a sign that SSA is taking the information revolution seriously. These progressive maneuvers are reflected in ICT growth rates. In 1997, fewer than 12 countries in SSA had Internet access; in 2000, with the exception of Somalia and the Republic of Congo, all of SSA had access to the Internet, capitalizing on about a 20% growth rate between 1999 and 2000 (World Bank, 2001)—today, all countries are connected. However, even with such dramatic improvements, Internet access remains a distant reality for most SSA citizens.

In addition to fixed lines, wireless technologies can significantly improve the teledensity statistics. Fixed lines need the physical laying of copper cables, telephone poles, and switches, all of which are subject to disruptions in the events of severe weather and human intervention (for example, civil conflicts where telephone wires are severed to cut off communications). But the privatization or liberalization of telecommunications across most SSA countries is offering opportunities to use newer forms of technologies that are unimpeded by typical landline service disruptions, and simultaneously utilizing the available radio frequencies for communications. Most citizens have come to rely on cell phones, thanks to relatively lower bureaucracy, less infrastructure dependence, and wider coverage using satellite services. Wireless technologies can weave a communications net across both urban and rural SSA, providing much-needed universal information access. Wireless technologies can complement land-based infrastructure including copper and fiber-optic cable. For example, SSA has widely committed to VSAT (Very Small Aperture Terminals), a small, software driven data, video, and voice communication technology that can provide a communication backbone in conjunction with wireless telephony with relatively little infrastructure investment. Uganda, for instance, has been able to combine wireless and VSAT technologies to increase rural participation and information access at a small fraction of the cost of alternative landlines. This combination of wired and wireless communications infrastructures is benefiting many SSA countries and has greatly improved the overall connectivity of these nations. We believe that if this trend continues in SSA countries, the long-term benefits will be huge.

A tremendous number of unanswered questions follow much of the discussion in this section. Although far from exhaustive, we present some of these research questions below to help other

researchers glean and construct their own research questions on ICT infrastructure adoption and implementation in SSA.

1. How relevant is teledensity—both the traditional measurement based on landlines and a more contemporary perspective based on mobile subscriptions—to understanding the development of ICT infrastructure in SSA today? Most developed countries have built their national data communications networks initially starting with land line voice communications, but does SSA need to go through this stage? Is there a sufficient market for data communications that network investments could be optimized for data rather than voice? Could voice over Internet Protocol (IP) on data-focused networks simultaneously meet SSA's growing needs for voice and data communications? Could small entrepreneurial ventures featuring wireless or voice over IP bypass the bureaucratic government telecommunication offerings? Particularly interesting are countries such as Gambia and Mauritania where, although per capita GDP is less than US$400 per year, wireless teledensity raises the total teledensity to above 10 citizens per 100 (see Appendix B). It is necessary to explore the reasons why so many poor people so value mobile telephony that they will pay such a large price (relative to their incomes) for them.
2. One ongoing debate on how to expand ICT infrastructure in SSA is whether to focus on the relatively more developed urban areas, or to aim for universal access for the predominantly rural population that may have a greater need for roads and clean drinking water than for telephone lines. While the more developed Northern and Southern regions of Africa might be able to develop teledensity infrastructures that would benefit the average citizen, would this goal be practical for SSA? Although focusing on telephones and related infrastructures for the urban elite of SSA risks widening the "within-country" digital divide (Straub, 2003), would this nonetheless be the most practical long-term approach? Can SSA leverage its existing ICT infrastructure to cope with future endeavors?
3. It is widely believed that privatization of the telecommunications sector will allow for free enterprise and competition. A few SSA countries have started to do this and have experienced some growth since the year of their privatization (UNECA, 1999a). However, considering that most of the new operators are enterprises based in Europe and the United States (ITU, 2001), there is concern whether the execution of privatization policies will benefit SSA in the long run. First, there would need to be research investigating if privatization is even appropriate in the SSA context. It could be that government control would work best in most SSA countries, with the appropriate policies in place. If privatization indeed would be beneficial, what is the optimal balance between government, local private, and foreign private control? How can SSA countries retain the benefits of their privatized telecommunications within their countries in the case of foreign ownership and avoid neo-colonialism?
4. A serious problem with telecommunications resources in SSA is the high dependency on foreign technicians for operation and maintenance of equipment. There is an acute shortage of local expertise (Mbarika, 2000). Often, many in SSA countries do not even trust their own local experts, but would rather bring in expatriates from Europe and the U.S. (IDRC, 1998). Research is needed on best practices to both train and retain local experts, many of whom flee to the West for "greener economic pastures."

ICT Infrastructure Development, Diffusion And Application

Upon adoption of an ICT infrastructure in SSA, its development must remain the paramount concern. ICT development relies on how well ICT investments are translated into resources for sustained competitive advantage. While we agree that most SSA countries will not gain sustained competitive advantage vis-à-vis developed countries in the near future, we argue here that individual SSA countries can gain such advantages over other SSA countries and, by extension, other developing countries. Historically, competition within SSA countries and between SSA countries and other countries has not been a priority. This has been so because most companies within SSA have been government-owned and -controlled. Within the past decade, with pressure from the World Bank, the International Monetary Fund (IMF), and other international donor organizations, SSA countries have been going through a massive wind of privatization in most of their economic sectors. These newly privatized companies are now going beyond their traditional within-country (national) markets to compete internationally (for both developing and developed countries' markets). Harnessing ICT for competitive advantage is a growing phenomenon in SSA, warranting much research attention.

ICT can create competitive advantages when they allow for cost advantages or competitive differentiation (Keen, 1991). Sustaining competitive advantages from an ICT infrastructure requires developing resources that are hard to imitate by other countries, and is very much a function of how ICT infrastructures are adopted, developed, and managed (Mata, Fuerst, and Barney, 1995). The complex weaving of socio-cultural and technical attributes brings about a certain causal ambiguity and imperfect mobility, to impede imitation. The resource-based view does not support any sustainable advantage from ICT, but confirms that it is only the development, management, and use of ICT that propels sustenance. Although Grant's (1991) classification scheme for resources is an older framework that originated in a developed-country context, we find it nonetheless valuable for assessing SSA's current infrastructure. According to Grant (Grant), ICT infrastructure development can be classified in terms of tangible, intangible, and personnel-based resources:

Tangible (Physical) ICT Resources: As discussed earlier, physical infrastructure resources in SSA have commonly consisted of handed-down IT artifacts: eclectic, ad-hoc, and misaligned with national needs and priorities. Physical infrastructure resources are existing tangible resources, such as PCs, landline telephone networks, and cellular telephones, among others. Bharadwaj (2000) found that physical resources can add value only if they are able to outperform other physical assets used by other countries. SSA, at this stage, has mostly relied on handouts and blind acquisition of physical ICT resources. It is unlikely that SSA's physical ICT resources will add requisite competitive advantage in the development of ICT. However, more prudent investments in emergent technologies can be used to complement legacy ICT to create the necessary infrastructure portfolio. For example, the acquisition of cellular technologies and linking them to existing VSAT systems can help develop unique resource combinations for SSA.

VSAT platforms and GSM installations are creating valuable opportunities for SSA. Independent of physical restrictions, it is cheaper to set up VSAT terminals and local cellular repeaters, linked to the main cellular network via satellite vis-à-vis terrestrial landlines. In addition, as technology progresses, hand-offs between VSAT and cellular can create a seamless networked link. With the capability to connect very large distances quickly and economically, VSAT and GSM technologies create a unique resource combination to create a better communication turf for investors, both foreign and domestic, as well as to diffuse internal capabilities, from education to legislation. Today, most SSA countries have a VSAT system under development or near

completion such as Netcom Africa in Nigeria, Internet Gabon, Egyptsat, and Pronet in Zambia, Malawi, and Botswana (Careless, 2005). While terrestrial independence is sought after, it also poses a problem with control and monitoring, especially under conditions of political instability and duress. Also, with satellite and cellular technologies, ownership is compromised for the sake of speed of installation. Nonetheless, such technologies offer tremendous value for SSA as they can potentially overcome years of under-development.

Intangible Resources: The development of intangible resources is key to ICT infrastructure development in SSA. For SSA to sustain itself, it must look beyond survival and learn to leverage its ICT infrastructure for competitive advantage. Intangible resources are those embedded in culture, practice, and norms of development and orientation that complement tangible ICT resources. Intangible infrastructure resources are the enablers of competitive advantage, as they have the ability to complement existing ICT infrastructure with current practices for sustainable resource complementarity. According to Bharadwaj (2000 p. 174), "a question that is becoming exceedingly important … is 'how do investments in technology create superior intangible resources…?'" Intangible resources include factors such as quality of physical infrastructure resources and their deployment, the alignment of the physical infrastructure to the national environment, and the level of synergy between national culture and ICT, among others. In the context of SSA, developing intangible resources is critical. SSA needs to look beyond handed-down ICT resources and implement ICT resources that users in their countries and region need. The ICT resources have to be deployed beyond urban developments to the rest of the population who are in dire need of them. If the national environment is rural and dispersed, satellite-based physical infrastructure would lead to a more relevant investment and coherent policy implementation. An example is found in how SOFT, a small start-up operation in Ghana, has been successfully competing head-on with larger Western software manufacturers (BBC, 2003). By tailoring its products to the unique cultural needs of Ghanaian businesses, SOFT has developed a service portfolio enabled by existing ICT infrastructure, complementing the current portfolio of intangible ICT services.

Personnel-based Infrastructure Resource Development: Personnel-based infrastructure resources are human resources that help develop and integrate ICT resources to policy objectives, conceive of innovative solutions to existing processes, and support and train members to create solutions attuned with the national focus (Bharadwaj, 2000). ICT personnel play a distinctly important role in ICT infrastructure development in SSA. ICT capabilities are often measured in terms of "conversion effectiveness:" the ability to develop information ICT resources from ICT investments (Lucas, 1978). Conversion effectiveness is contingent upon the effectiveness of ICT personnel who provide technical and managerial assistance. Technical personnel look at supporting and maintaining the existing ICT infrastructure, something that SSA has historically imported. ICT managers, on the other hand, look at ICT resource allocation and accountability, they supervise functionality, and they help in the transition to innovative use and application of ICT. The managers also act as liaisons with legislators, thus aligning legislation to ICT priorities through liberalization, amendments, and deregulation. In Tanzania, for example, the Ministry of Communications and Transport is in the final stages of enacting a national ICT policy with far-reaching implications for the development of ICT nationally. The policy's goal is to bridge the digital divide between Tanzania and the world, as well as within the country. Thus, the policy specifically attempts to develop ICT infrastructure and access for all Tanzanians; creating local content that is relevant, coherent, and useful for the population; and increasing human capital development by increasing information diffusion across masses. To make this a reality, the Tanzanian government understood that tangible, intangible, and personnel-based ICT development must occur simultaneously. Combining prudent acquisition of useful ICT technologies, training and developing policies well suited to their national

environment, and training of personnel to support and further develop the ICT infrastructure, Tanzania is trying to develop a unique developmental mix that will bridge the digital divide. Because each of these factors varies by country and region, ICT development truly becomes an idiosyncratic combination of resource factors. The idiosyncratic property of infrastructure development provides the differential advantage or disadvantage that sets apart resource development and its use across national economies within SSA.

What makes ICT infrastructure development a unique resource is based on distinct dimensions. Using Barney's (1997) assumption that resource factors involved in infrastructure development are heterogeneously interacting and distributed across an economy and remain so over time, one can infer that resource development across comparative economies remains distinctive. The heterogeneity gives rise to isolating mechanisms in terms of time compression diseconomies (experiential learning impacts on infrastructure resource development time), degree to which resources are embedded (complementary or co-specialized linkages among resource factors), and causal ambiguity (ambiguity concerning the exact path by which outcomes are achieved across economies) (Bharadwaj, 2000). In our ecosystem framework, it is not only the complementarity of resource factors within infrastructure development, but also the role of infrastructure adoption that can relate to the creation of "unique," rather than commoditizable resources.

Such developmental initiatives are partially underway in SSA. Nonetheless, ICT use in SSA is restricted to the educated few, largely non-representative of the 70% rural population. According to the United Nations Economic Commission on Africa (UNECA, 1999b), most Internet users are male, hold a university degree, have the ability to speak an international language (that is, English, French, Portuguese or Spanish), primarily use e-mail to communicate with others in international locations, and are generally affiliated with nongovernmental organizations, private firms (mostly multinationals), and universities. Restrictive censorship practices have also impeded ICT infrastructure development. Countries like Sierra Leone and Sudan constantly monitor and control the few connections into the country, making it difficult for the general population to freely access public information and diminishing positive network externalities from user subscriptions. President Chiluba of Zambia invoked the State Security Act to ban an online newspaper that had criticized his administration. Such direct censorship of inflow and outflow of content on the Internet has severely impacted ICT infrastructure development. Apart from political reasons, economic reasons also drive national agendas in SSA, where state-controlled telecommunication monopolies are revenue streams that governments do not wish to lose through deregulation. Access costs are prohibitively high, as discussed earlier, with the rerouting of traffic through Europe. This precludes the public from enthusiastically using ICT as tools for information exchange. In addition, the government has rarely promoted ICT to the general populace, which has paradigmatically perceived such technologies and information needs as belonging to the urban elite.

However, with newer and cheaper ICT, ICT infrastructure development in SSA is undergoing a paradigm shift. Cell phones, satellite communications, the SAT3/SAFE/WASC telecommunications initiatives for cheaper and faster access rates, and the New Partnership for Africa's Development are converging as a boon for SSA. There is a definite rise in interest in kiosks, cybercafés, telecenters, public Internet access sites in community centers, police stations, libraries, clinics, hotels, and other locations. Internet access terminals are even beginning to be seen in telephone booths. Networks and ISPs are beginning to be deregulated, and emergent technologies such as IP telephony are bringing to the fore the untapped potential of ICT applications. In addition, 3G GSM wireless devices are promoting Internet access via cell phones, trying to weave urban and rural areas as a giant telecommunications net. With the

paradigm shift, a new generation of information workers is also in the making. By proactively becoming involved in ICT infrastructure adoption, SSA is elevating its own base of personnel trained in the service, maintenance, partial development, and application of ICT. And it is exactly this marriage of ICT resources and personnel that can incite SSA to develop "unique" capabilities in its application and use of ICT.

There are several research questions that can be elicited from this discussion of ICT infrastructure development and applications:

1. Meso and Duncan (2000) described how different components of a national ICT infrastructure affect socioeconomic development. Using the resource-based view, mapping the relationship between ICT technologies as resource factors will be an important step in identifying the roles, interactions, and outcomes of resource factors in the infrastructure. Moreover, the weights assigned to each resource factor will vary across economies. Understanding the reasoning and implications of the weights can provide a better realization of ICT resource development. What types of services would different ICT perform? Would they be commercial or non-profit? What would it take to implement such technologies and services? How would sponsorship play a role in ICT adoption and development? Does development in SSA need to follow a sponsorship model? Should privatization lead the way or would a hybrid model work? Would there be distinct variances by technology adoption and developmental patterns, or by regions and countries?
2. As we discussed earlier, it is the assemblage and mobilization of infrastructure development resource factors that create infrastructure capabilities. However, are assemblages linear or non-linear? That is, do the pertinent resource factors each have a distinct, cumulative effect (linear), or are they effective only when they interact with each other (non-linear)? For example, infrastructure capabilities are a function of the users of the infrastructure. Using Metcalfe's law, the value of infrastructure capabilities would be more a square of its user base. The question is, how could the user base be developed? What are the challenges and pitfalls in resource factor mobilization? Interestingly, this requires a better understanding of infrastructure assemblage and investment and resource mobilization. For SSA, infrastructure assemblage must begin with an objective assessment of the region's needs and then follow with investments in computers, communications, and content delivery modes that can offer value. This requires well-trained and well-experienced purveyors, something relatively lacking in SSA. The question then is, should SSA hire foreign personnel on a turnkey basis to consult on technology needs, infrastructure assemblage, and investments direction? Or will that lead to a biased recommendation? Investigating such intrinsic factor characteristics and infrastructure capability creation processes can provide a more granular assessment of the interplay of multiple entities and events that mobilize and shape investments and enable unique resource combinations.

Socioeconomic outcomes of ICT resources

On successful adoption and development of ICT in SSA, we subsequently examine socioeconomic applications of the installed ICT infrastructure. While socioeconomic applications are varied, the scope of this paper restricts our investigation to applications and outcomes particularly relevant to SSA. This research agenda specifically focuses on telemedicine and online education as social applications, and electronic commerce as an economic application of ICT.

Two of the most important aspects of social infrastructure in any nation are healthcare and education. Without adequate healthcare, population growth rates are stunted and citizens' quality-of-life is severely curtailed. Any investment in human capital would be limited in its potential, as the citizens would not live long enough to materialize such investments. To cover this area, we consider how telemedicine can use ICT to improve healthcare in SSA. Closely following healthcare, education is critical for developing human capital, which is the most vital resource any society might have. Thus, we consider how online education can take advantage of ICT to provide extended educational opportunities. Finally, once the social infrastructure is established, SSA countries need a self-sustaining economic base so that they will not be forever dependent on foreign aid. Moreover, such a base would provide home-grown resources for further investment in healthcare and education, both ICT-enabled and traditional. To explore this economic dimension, we discuss the possibilities that e-commerce offers to SSA. We address these areas of potential research in the next few sections of the paper.

Social Outcome of ICT resources: Is Telemedicine A possible solution to SSA's medical nightmare?

The delivery of healthcare is inarguably one of the most fundamental needs for SSA, considering the region's medical quandary, with growing medical problems in the face of an acute shortage of medical facilities and personnel. Much of the practitioner literature reports on the many medical problems of SSA. The World Health Organization (WHO) reported that by the end of 2001, an estimated 40 million people worldwide—2.7 million of them younger than 15 years—were living with HIV/AIDS. More than 70 percent of these people (28.1 million) live in SSA (WHO, 2001). Furthermore, malaria kills more than one million children each year—2,800 per day—in Africa alone. In regions of intense transmission, 40% of toddlers may die of acute malaria, even though there would be a good chance of survival with timely medical attention. Other diseases that kill millions of Africans each year include very treatable ones like dysentery, cholera, typhoid, and yellow fever, among others.

Unfortunately, SSA is simultaneously faced with a shortage of medical personnel. SSA has fewer than 10 doctors per 100,000 people, and 14 SSA countries do not have a single radiologist. The few specialists and services available are concentrated in cities. Poor roads, scarce and expensive telephones, and a lack of library facilities isolate rural health workers--who serve most of the population--from specialist support and up-to-date information (Fraser and McGrath, 2000).

In a bid to find a solution to the growing medical problems of SSA, many governmental, non-governmental, and international developmental organizations have lunged at the opportunity of telemedicine. The International Telecommunication Union has organized several missions of telemedicine experts to selected African countries. These missions tried to identify Africa's needs and priorities for the introduction of telemedicine services, taking into account the state-of-the-art of the local telecommunications networks and their evolution (ITU, 2000). HealthNet, the most developed Africa-wide initiative, aims to improve the practice of telemedicine by linking health care professionals around the world (SATELLIFE, 2001). HealthNet has conducted numerous projects since the mid-1980s, involving physician collaborations, medical data collection, health care delivery, medical alerts, access to medical libraries, and medical research.

In spite of successes such as HealthNet, there have been various obstacles to telemedicine penetration within the continent. Above all, most of SSA's telecommunications networks are very poorly developed (Mbarika, 2001). Thus, we've made pertinent arguments for the need to

establish comprehensive national ICT infrastructures before telemedicine can be realized. Even in urban areas with telecommunications infrastructure, the shortage of telemedicine expertise limits its adoption. Moreover, many African countries cannot afford the very sophisticated telemedicine solutions involving ATM, virtual reality, and other advanced technologies. These obstacles notwithstanding, telemedicine adoption is still important and feasible for most, if not all, SSA countries. Table 2 describes the importance and feasibility of telemedicine adoption in SSA (Mbarika, 2003).

In the last decade, several telemedicine projects have been initiated in SSA with some degree of success. Here are a few examples (Mbarika and Okoli, 2003; Mbarika, 2004):

- In 1998, the International Telecommunication Union, Telecommunications of Mozambique (the country's main telecommunications operator), and WDS Technologies of Geneva established a telemedicine link based on existing terrestrial and satellite telecommunications systems between the central hospitals of Beira and Maputo in Mozambique (ITU, 1998). The project enables the hospitals to rely on standard low-cost tele-radiology equipment for the transmission and exchange of images and radiographs as well as their visualization.
- The Lille Regional University Hospital and the European Institute of telemedicine in Toulouse partnered with health institutions in Senegal to use videoconferencing for tele-consultations between health professionals (Dlamini, 2001). In-service distance training for health professionals is one of the key components. Training occurs in remote health centers through videoconference systems customized for medical use.
- Having been implemented in 20 countries throughout Africa, HealthNet is the most developed Africa-wide initiative, which aims at improving the practice of telemedicine among health professionals. HealthNet is SATELLIFE's computer-based telecommunications system that links health care professionals around the world (SATELLIFE, 2001). Using a low earth orbit satellite and phone lines, it provides email access in SSA countries, serving over 10,000 healthcare workers. Where adequate telecommunications links exist, SATELLIFE and other organizations provide higher capacity email and Internet connections, which allow sending email attachments such as image files, permitting a form of low cost telemedicine.

It is noteworthy that in all three cases cited here, there has been considerable contribution—both financial and in terms of personnel— by sponsoring organizations in developed countries. It seems that it is currently premature for the healthcare industry in most SSA countries to fully support independent telemedicine projects. However, the support of local governments and local academic institutions is also crucial (Solomon et al., 2004). Today, many African governments have been fully committed to promoting many different dimensions of health informatics (telemedicine included), resulting in many new projects in various African countries. In 2005, Ethiopia launched various tele-dermatology initiatives, one of which saved the life of a little boy at the Minilik Hospital in Addis-Ababa [personal observation by one of the authors].

Table 2: Importance and feasibility of telemedicine adoption in SSA

Why telemedicine adoption is important and necessary

- There is an overwhelming need for the provision of medical and health care services, especially in areas outside the cities.
- Telemedicine links between hospitals and other medical institutions could bring overall improvement of health-care services by centralization and coordination of resources (specialists, hardware and software packages).
- The modernization of internal communication in the hospitals could considerably improve the efficiency of health-care delivery. It will be the basis for the introduction of telemedicine services.
- The maternity units in any region could be connected by a telemedicine link to the maternity service in a large regional hospital or to the referral hospital. This will allow remote monitoring of the health of pregnant women, especially those with pathological problems (ITU, 2000).
- Tourists would be encouraged to visit the country and visit remote areas if there is a facility for telemedicine. From all medical emergencies, good and qualified medical attention may be provided with the backup of telemedicine service.

Why telemedicine adoption is feasible

- There is substantial experience and expertise with regard to telemedicine in developed countries such as those in Europe, Canada, the United States and Japan.
- The provision of health-care already consumes a large portion of national budgets.
- The Internet is making inroads into Africa: whereas in the mid-90s only about 12 countries in Africa had Internet access, it is now available, at least in the capital city, in all African countries.
- Some global satellite networks such as those provided by HealthNet, Inmarsat and Intelsat have already been used for the delivery of telemedicine services to remote and rural areas.
- Most African countries are members of global satellite organizations and of RASCOM, and have in place earth stations, which could be used for such delivery. Past research shows that such African-Foreign alliances can provide the opportunity for African countries to improve on their telecommunications infrastructure such as those needed for the adoption of telemedicine (Mbarika et al., 2002b).
- E-mail has many benefits for poor countries: it is cheap; hardware and software requirements are simple; and the information does not have to be transmitted in real time.
- The deployment of fixed or mobile telecenters are now considered a good solution for bringing telemedicine services to rural areas (ITU, 2000).

We again give some examples of research questions that follow from our discussion, now concerning telemedicine:

1. There is a need to examine overall best practices in the adoption, implementation, and diffusion of telemedicine in SSA. What are some of the enablers of and obstacles to the successful adoption, implementation, and diffusion of telemedicine in SSA? How do these relate to the cultural, social, political, and economic traits of SSA as a whole, and of individual countries in SSA? Are there differences in these countries in the possible successful implementation of telemedicine? What levels of ICT infrastructure are needed for successful implementation of telemedicine?
2. What are the appropriate technologies for telemedicine in SSA, since broadband technologies are almost nonexistent in the region? How can “low-tech and low-cost”

solutions like e-mail be utilized to bring better healthcare to remote areas of SSA? Can low-cost technologies like e-mail be modified, improved, or redesigned in some way to help bring a relatively high level of healthcare to remote areas of SSA? Will wireless technologies be able to quicken the diffusion of telemedicine in SSA? How can wireless technologies be improved, changed, or modified to be more effectively applied in telemedicine in SSA?

Social Outcome of ICT resources: Is Online Education a Panacea to SSA's educational dilemma?

Having addressed healthcare, we now turn to education as another important area of social development. The dilemma of low levels of education in SSA dates from the years of colonization, during which the West (Europe and North America) controlled and directed the region's resources. The primary purpose of the colonial West was not to educate Africans, but to exploit the region's natural (gold, silver, diamonds, oil, rubber, timber, etc.) and human (cheap or free labor) resources (Amin, 1976; Amin, 1990; Griffiths, 1995; Larrain, 1989; Rodney, 1981).

Under colonial rule, access to education in Africa was restricted, as were curricular offerings (Lewis, 1999). African children were prepared for the roles deemed appropriate by those in power. Sons of chiefs had privileged access to schooling, a practice that served both religious and political motives that mainly benefited the colonial West. Such a practice was followed by most African families that gave priority mostly to the education of boys, leaving a large population of girls uneducated so they could later serve the men as childbearing machines and housewives. Prior to independence, few African children attended school beyond the primary level. By 1960, only 25% percent of children of primary school age were in school, compared to twice that level in Latin America and Asia (Lewis, 1999).

For several decades, the SSA region has lagged behind other parts of the world at the primary, secondary, and especially post secondary educational levels. At the post-secondary level, there is intense competition for the few available institutions, leaving many otherwise qualified students unable to attend school. In fact, some African countries have only one university, which is state-run. This shortage of higher educational facilities has contributed to a great migration of African students who leave the continent to study and work abroad (especially in Western countries), with no plans to ever return to Africa. This "brain drain" creates a vicious cycle that places African countries even farther behind other countries in terms of socioeconomic development (Wilson and Darmuzey, 2000).

HIV/AIDS presents another serious problem for education in SSA. AIDS has taken a toll on primary and secondary school enrollment, and has decreased the pool of qualified teachers. In 1998, more than 1,300 Zambian teachers died of AIDS, a number amounting to two-thirds of the teachers the nation trained that year. The United Nations Population Fund (UNPF) reports that nearly 1,500 Kenyan teachers died in 1999, up from just 10 teachers in 1993 (Crawley, 2000). This has significantly reduced the number of available teachers in SSA countries.

Online education offers a possible solution to SSA's education dilemma. Such education has been making in-roads in many developing countries, including those in SSA. Online education is expected to be particularly relevant in African countries such as Ethiopia, Rwanda, Congo, and Somalia, which are emerging from prolonged wars and whose work forces lack vital technical skills (USA Today, 1999).

As in the case of telemedicine, online education is heavily dependent on the existence of national ICT infrastructures, particularly Internet-based. Thus, the arguments concerning infrastructure investment, implementation, and adoption are precursors to this social application. However, given the existence of a working ICT infrastructure, online education requires minimal capital investments and operating costs relative to traditional teacher training. It represents a unique opportunity for sharing resources at affordable prices to large numbers of people (Darkwa and Mazibuko, 2000). For example, digital libraries such as UMI and EBSCO offer access to the abstracts—and often full text—of thousands of journals and magazines, invaluable to the research of students and academics. This is especially important for colleges and universities within the SSA region that have slim budgets for acquiring expensive library resources (USA Today, 1999). Realizing the role of online education in developing countries, Egyptian President Hosni Mubarak (one of Africa's leaders) stated:

> The Digital Gap of income and education unevenness needs to be bridged by digital opportunities of new tools and equipment. The Tele-revolution, exemplified by telemedicine and online education, shortens physical distance separating those in need from the service or commodity that they want. It thus provides a unique opportunity for the projection of talents across borders and exchange of experiences across different systems. (Mubarak, 2000)

In recent years, several online education projects have been implemented in Africa as a step toward improving the continent's educational opportunities:

- The African Virtual University (AVU) provides college-level education to Africans (www.avu.org). ICT applications used for the AVU initiative are integrated with satellite technologies to provide educational content to Africans at an affordable cost.
- The Botswana College of Distance and Open Learning (BOCODOL) provides education at the secondary school level, as well as basic vocational, professional and management courses for the labor force (SAIDE, 1999).
- The Distance Education Association of Tanzania (DEATA) enrolls more than 18,000 in different higher education programs and courses, as well as special programs for adult learners. The DEATA program also provides free educational opportunities for Burundian refugees[1] (SAIDE, 1999).
- In Ghana, Hewlett Packard (HP) is sponsoring a consortium of Kwame Nkrumah University of Science and Technology and University of Pennsylvania School of Engineering and Applied Sciences to create the "HP Digital Village." Using HP technologies and solutions and DSL lines from Ghana Telecom, 50 resource centers will be linked nationwide for cost-effective workforce creation through virtual education opportunities (Cobbinah, 2003).

It is encouraging to see that many of these online education initiatives are home-grown and locally-maintained with little, if any, support from foreign aid. This model provides opportunities for SSA to develop an independently-minded workforce that is sensitive to the region's unique needs.

We provide research questions to guide future investigations in education below.

1. Similar to telemedicine, there is a need to investigate overall best practices in online education in SSA. One way to do this is to examine current successful practices in other developing countries. Do these current practices inform adequately about online

[1] The Burundian refugees were victims of the civil wars in the mid-90s.

education to help understand and implement online education in SSA? What levels of ICT infrastructure and technologies are appropriate for SSA, and do these levels differ from more developed countries? For example, are basic technologies like old computer systems such as 486 PCs adequate to serve the markets in SSA? A very important question is how to bring equipment to the masses while thwarting its theft and destruction.

2. How can online education such as African Virtual University (AVU), the Botswana College of Distance and Open Learning (BOCOGOL), and the Distance Education Association of Tanzania (DEATA) be leveraged and further developed? How can the successes, failures, and needs of these education initiatives inform us about the enormous task of educating the masses in SSA? Can these types of initiatives be improved and implemented on an even wider scale throughout SSA? What world and regional agencies are best equipped to help or become directly involved in online education in SSA?

Economic Outcome of ICT resources: Is Electronic commerce A vital link for SSA's economic development?

In addition to the social outcomes of telemedicine and online education, it is also important for researchers to address economic outcomes of an ICT infrastructure. The primary economic outcome we examine here is electronic commerce (e-commerce). Although e-commerce has been very successful in the North, there are several factors precluding its smooth adoption and effective deployment in Sub-Saharan Africa. To understand these factors, it is helpful to examine the infrastructure that is required for the establishment of effective e-commerce practice. This "infrastructure" includes not only physical artifacts such as telecommunications networks, but also institutional features such as economic policies and social practices conducive to the conduct of business using ICT. To lay a foundation on which research in this area could proceed, we will examine the context for e-commerce in SSA from the perspective of two frameworks in the e-commerce literature. First, we have Zwass' (1996) generic "framework for electronic commerce," that assesses the different dimensions of e-commerce in general (Kimbrough and Lee, 1997; Vadapalli and Ramamurthy, 1998). This framework attempts to be generic and universally applicable. However, it is tailored to the context of a developed country, and implicitly assumes the social and legal backdrop of the United States of America. Thus, we will also examine the e-commerce context in SSA using a framework proposed by Travica (2002), which directly examines the factors necessary for the commercial application of ICT in developing countries (Dutta, 1997).

Zwass (1996) identified three general levels of e-commerce. Using these levels as a guide, we can assess various aspects of the state of electronic commerce in general in SSA. First, the infrastructure involves the physical layer, the network layer, and hypermedia. In SSA, aging and unreliable copper-line telephone networks at the physical layer provide the main data infrastructure, and are currently restricted to major cities. However—and largely for this very reason—wireless cellular networks are burgeoning. At the network layer, although the number of ISPs is rapidly increasing, few SSA countries have international Internet exchanges. Moreover, regarding hypermedia, while use of different Internet services such as e-mail is increasing, the use of the World Wide Web—critical to e-commerce—is lagging behind. Zwass' (1996) second level involves e-commerce services. Currently, Short Message Service via cellular networks is used more widely than e-mail as a means for interpersonal messaging (Hamilton, 2001). There is currently poor financial infrastructure for functional electronic funds transfer. Important emerging Internet support services include speech-mail that can serve the high number of illiterate citizens (Hamilton, 2001), and digital libraries that could bring in a flood

of previously inaccessible information. Zwass' top level involves e-commerce products and structures. Journalism is a primary commercial application of ICT in SSA; other nascent applications include shopping (e.g. GhanaMall at http://www.ghanamall.com.gh) and banking (Hamilton, 2001). Product markets are presently very limited. However, "Africa has a unique competitive advantages [sic] in … Business-to-Business export teleservices, an area which happens to be one of the fastest growing markets" (UNECA, 1999c).

Zwass' (1996) framework approaches e-commerce primarily from a general technical and application perspective, focusing on the potential capabilities of e-commerce for individual and business users. Another perspective that explicitly incorporates factors relevant to e-commerce in a developing country is a framework developed by Travica (2002) for his study of e-commerce diffusion in Costa Rica. While his focus is limited to business-to-consumer e-commerce for physical goods, its developing-country context is particularly valuable in assessing the e-commerce readiness of the SSA region. His framework considers six levels of e-commerce infrastructure for a developing country:

1. **Transportation.** Only 12.3% of the roads in SSA are paved (World Bank, 2001), which restricts the delivery of physical goods.
2. **Delivery.** Public postal systems are not secure and expensive courier services discourage e-commerce based on physical delivery. Moreover, these delivery services reach very few of the non-urban citizens who make up 66% of the population (World Bank, 2001).
3. **Telecommunications.** SSA countries face several problems: a huge gap between supply and demand; a strong distribution imbalance favoring urban over rural areas; poor quality of service; a long waiting time for new service; and peak traffic demands that exceed network capacity (Mbarika, 2001). Although efforts by the International Development Research Centre are underway for grassroots development of telecommunications infrastructure, the imbalance still remains—largely due to inherent socioeconomic complexities and problems (Adam, 1996).
4. **Software Industry.** The "lost continent of the information technologies" has fewer computers and lower ICT expenditure per capita than any geographically comparable region (Mursu et al., 1999; Odedra et al., 1993 p. 25). Similarly, there are few schools with computer science programs to develop an indigenous base of software developers.
5. **E-payment.** Credit cards are not widely used because of low standards of living and rampant fraud. Checks and money orders are an option, though these extend transaction time.
6. **Consumer E-commerce Culture.** Africa's open-air market culture is at odds with the virtual shopping culture of e-commerce. Moreover, SSA consumers are not widely comfortable with computers or e-mail, which is necessary for the requisite trust to engage in e-commerce. While business people and workers in government, healthcare and education are increasingly using e-mail, the average buying consumer does not yet use e-mail.

We have discussed two general theory bases that help our understanding of different aspects of the Internet and e-commerce in SSA. A general theory of e-commerce, typified by Zwass' (1996) framework, gives an overview of the different levels of the technical infrastructure and business issues that contribute to the practice of e-commerce. This application-oriented perspective is very practical and focused, but it requires a further recognition of the organizational and environmental context in which e-commerce occurs. This is particularly necessary for studying developing countries, where we must consider the many issues that these countries face that are not major factors in the developed countries in which most theories

of e-commerce and IT diffusion are set. Travica (2002) provides a good framework that captures many of these issues in dimensions that foster more careful analysis. It explicitly incorporates many important factors that the other frameworks take for granted, such as infrastructure for physical transportation of goods and consumer culture pertinent to e-commerce. However, this framework is limited in that it is tailored only for B2C transactions involving physical goods, which is only one segment of e-commerce.

Borrowing some terminology from Wolcott et al.'s (2001) Global Diffusion of the Internet framework, we can find points of integration between these two distinct approaches in terms of the ICT environment and the sophistication of Internet use. The ICT environment corresponds most closely to Travica's (2002) Telecommunications construct, and consists of Zwass' (1996) physical layer and network layer. The sophistication of ICT use covers the various issues that concern African users' ability, training, and inclination to use ICT effectively. It consists of the sub-categories of electronic markets (Zwass, 1996), consumer e-commerce culture, e-payment mechanisms, and the software industry (Travica, 2002). The software industry can be subdivided into four of Zwass' (1996) levels: secure messages, products and systems, enabling services, and hypermedia. These frameworks set a backdrop against which we can ask questions for further research on e-commerce in SSA.

Many businesses in SSA have tried to use the Internet, but profitable enterprise has been challenging. Still, there are some cases in which the Internet has assisted SSA businesses in attaining their organizational goals:

- Tourism has always been very popular in SSA, and the Internet has provided a cost-effective means for travel agencies to reach international audiences easily. A directory of African travel sites, such as at <http://www.africaonline.com/cgi-bin/odp/index.cgi?/Regional/Africa/Travel_and_Tourism/>, attests to the proliferation of such sites.
- An important aspect of e-business in SSA is carried out by the simple use of e-mail for communications and the Web for obtaining information to launch, improve, and market traditional businesses. For example, the past few years have seen an increase in West African individuals starting businesses in heliciculture (raising snails) and apiculture (raising bees) because of the widespread Internet information on techniques, methodologies, and how to obtain the necessary equipment. These have capitalized on the region's climate to help people take advantage of the resources they have.
- As more SSA businesses launch websites, one profitable sector is the Web services industry that creates and maintains these websites. There are many Web developers based in Africa who create websites for local and foreign companies, sometimes including e-business and e-marketing consulting. Examples are found at <http://www.italconcepts.com>, <sohne.net>, and <http://www.whitesys.net>.
- Most e-business websites are limited to catalogues of products and services, with little interactivity. An exception is Net Shoppe <http://www.netshoppeonline.com>, a distributor for HP products in Accra, which provides online ordering, including a shopping cart. However, because of the infancy of the e-payment infrastructure in Ghana, payments are handled through traditional means, such as invoicing, COD, and local pick-up. This model takes advantage of the efficiencies of order processing without introducing payment delays, particularly for repeat customers who already have established accounts.

A large number of other e-commerce sites in SSA are listed at http://www.webgh.com. While this site is limited to Ghanaian sites, it gives a comprehensive view of the range of what is currently being done in an SSA country. E-commerce as an economic application of national ICT resources is the last dimension of the ICT ecosystem we described.

Our discussion of e-commerce has implied a number of possibilities for promising research. We give some examples below:

1. What kinds of physical, economic, and socio-political infrastructure are needed for the establishment of viable e-commerce in SSA? Most research in e-commerce is set in the context of developed countries, though there is an increasing amount of e-commerce research specifically focused on developing countries (Darley, 2001; Dutta, 1997; Mbarika, 2001; Mbarika et al., 2002b; Montealegre, 1996; Montealegre, 1998; Montealegre, 2001; Travica, 2002; Wolcott et al., 2001). However, SSA is a significantly different cultural region from even North Africa, its geographically closest socioeconomic region. What principles of e-commerce are universally applicable across world regions, and what principles are highly specific to the local socioeconomic conditions? What policies should governments and non-governmental organizations focus on to establish an environmental context amenable to e-commerce in SSA?
2. A related question concerns the geographic scope of e-commerce research frameworks. A framework like that of Zwass (1996) tries to be general, but is actually framed for developed countries. Travica's (2002) framework targets developing countries in general, though it was created for a study of Costa Rica. To what extent are existing or new e-commerce frameworks universally applicable? What aspects need to be tailored for developing countries? Can developing countries all be lumped together as if they are homogenous? Perhaps an empirical taxonomy of e-commerce infrastructures with the country as the unit of analysis could yield valuable insights into the most pertinent criteria to consider for international e-commerce.
3. E-commerce in SSA will be based on the foundation of traditional commerce in SSA. The examples of current e-commerce practice we gave are all in the context of traditional contemporary SSA commerce. We expect that, to some extent, e-commerce would be able to extend the traditional practice of commerce in SSA, but that it would also provide some disruptive new models of commerce that fit in the area's socioeconomic context. Although disruptive, some of these new models should prove economically beneficial to the entrepreneurs who adopt them (otherwise they will be phased out). What are the e-commerce practices that would be extensions of traditional SSA commercial practices, and what are the beneficial disruptive policies? Related to this theme, what factors have contributed to the success of the existing e-commerce applications in SSA, and what can new projects learn from them?

Implications

In this study, we presented the need for focused research on the development and applications of ICT for SSA. We argued that the IS research community has a unique and valuable perspective to bring to the ICT infrastructure challenges this region faces, hence extending the work in ICT diffusion and policy. We presented a research agenda for studying the adoption, development, and application of ICT in SSA. In particular, we discussed application domains that present important areas for potential research: teledensity, telemedicine, online education, and e-commerce. We generated research questions that could yield important new insight in these areas.

Throughout this paper, many references have been made regarding the existing socioeconomic and political dilemmas that exist in SSA. These dilemmas include poor teledensity infrastructure, a deplorable health sector, extremely low levels of education, and generally poor economic

status. However, those countries that have successfully implemented telemedicine, online education, e-commerce, and other related ICT, have taken major steps toward improving their socioeconomic development. We argue that the information-system research community has a unique and valuable perspective to bring to the ICT infrastructure challenges this region faces, hence extending the work in ICT diffusion and policy. Recent policy initiatives by the UN and USAID point to a more focused shift toward SSA. According to the U.S. Congressional Budget Justification Committee for the 2004 fiscal year, USAID (2003), "A more prosperous, healthy and stable Africa is in America's best interest, and contributes to U.S. efforts to foster world-wide economic growth and increased trade, and to combat transnational security threats." Aid and investment opportunities abound in eradicating terrorism, poverty, and strife while promoting health and democracy. To lead such developmental efforts, ICT has been chosen as the vehicle of choice and as a first step toward ending information starvation in SSA. To extend the work in ICT diffusion and policy, in this paper we developed an information ecosystem framework to encapsulate the application potential for ICT along with its underlying challenges. The ecosystem tries to re-envision the application, role, and spillover benefits of ICT for aiding developmental efforts. Much of the ICT investments in SSA today have failed to yield substantial benefits, and IT remains largely underutilized.

As a result, much of SSA is afflicted with blind computerization (Odedra et al., 1993) where countries are tempted by profiteering vendors who sell technologies but forget to mention their applications. Odedra et al. (1993 p. 26) justifiably remark, "Instead of trying to 'catch up' with the industrialized world, Sub-Saharan [countries] should instead use IT for selected and discriminated applications to bring substantial benefits to their economies and people. The choice of applications must match the priorities set by government and have a high developmental impact." Therefore, the arguments within this paper and those arguments that arise from other developmental researchers can bear major implications for research, teaching, and practice.

Implications for Researchers

The research agenda in this paper sets the stage for IS researchers to delve into this under-researched area. Researchers could use the scenarios and examples of how ICT can improve the socioeconomic status of SSA as a basis for research and field studies in SSA (and other developing) countries. This could lead to further development and testing of newer theoretical models grounded in IS literature that explains the process of the different ICT specific to the SSA region and other developing countries. Some of these theories address areas such as adoption and diffusion of ICT, design science in ICT, competitive advantage from IT, IT personnel training and shortages, and infrastructure models in the adoption and implementation of e-commerce. By grounding their research in theories from these areas, IS researchers could offer important new contributions to the academic and scientific community, industry, and government sectors in SSA and other developing countries.

Researchers could refine the research questions presented in this paper and develop hypotheses in the areas of telemedicine, online education, e-commerce, and other ICT applications with regard to SSA countries. This may provide a platform to develop research that could potentially be generalized to other developing countries.

This paper also adds to the debate on diversity in IS research. It offers a new angle whereby IS researchers can go beyond ICT issues in the developed world to examine IS issues not just in developing countries, but also in less advantaged parts of the developed world. Examples

include the diffusion of online education in rural communities in Canada and the diffusion of telemedicine on Indian reservations in Arizona.

Implications for Practitioners of Future work

For practitioners (policymakers, and nongovernmental organizations) in SSA and other developing countries, awareness of application possibilities for existing ICT infrastructure is thus seen as a prerequisite to more informed ICT policy and governance. The contributions point toward mutual advancements for both SSA and the rest of the world in terms of research and practice. Opening up a market of 633 million people would be more than welcome for industry and investors searching for new markets. Moreover, SSA is looking for new investors, enthusiastically supporting democratic reforms and property rights, and improving business and social practices. For research and practice, spheres of ICT use and innovative application developments bring forward new cross-border opportunities. In addition, the interplay of information technology with the complexities of culture, tradition, and perceptions of SSA would allow one to weave a rich research tapestry of issues and agendas.

Government policymakers will have new insights into the effectiveness of various national ICT policies on ICT diffusion in their respective countries. This could help these policymakers fine-tune their policies in a bid to encourage growth of ICT in SSA and other developing regions. Given rigorous research in this stream, providers of different ICT, such as equipment manufacturers and service providers, will have empirical findings on which to base organizational practices for both local and multinational organizations. For example, ICT equipment manufacturers (mostly based in Europe and North America) could develop systems that fit within the cultural and educational context of specific countries within the SSA region.

Beyond ICT, there are a plethora of major multinational companies headquartered in developed countries--such as Microsoft, GM, Exxon-Mobil, UPS, France Telecom, and British Telecom--that operate in the SSA region. Well-researched studies on diffusion of ICT to this region could benefit these companies and newer companies that intend to have a presence in the region. Such research could have publication potentials in other premier practitioner journals such as MISQ Executive and Academy of Management Executive.

Without a doubt, managers, policymakers, and other practitioners of ICT in SSA will have little control over some of the factors that might be found to be conducive to ICT development in the region. Wars are hard to prevent, and drought and international markets are hard to predict, for example. However, research such as we propose here could unearth possible factors, such as methods of training workers and introducing technologies, that might significantly increase the success of ICT projects, factors which practitioners could control. Such studies would help them prioritize their resources on managerial endeavors that hold the most promise for desirable results.

Implications for Teaching

Many SSA countries now have the opportunity to push for distance learning through ICT. Several US and European universities now offer courses over the Internet such that students in Africa have expanded opportunities to receive college-level education. Furthermore, African professors based in cities now have new opportunities to teach students located in rural parts of Africa with little or no access to higher education.

In the Western context of higher education, global ICT issues are drawing the attention of many business programs. This is evidenced by the growing numbers of IS programs that offer courses

on global information technology management, as well as the emergence of textbooks that address global ICT issues. In fact, most introductory IS textbooks have at least one chapter that addresses global ICT issues. Understanding ICT diffusion issues in SSA will add to the richness of such books and courses. More so, with global competition for the sale of goods and services, many companies that were once nationally- or locally-based are now becoming multinationals. IS graduates therefore have many opportunities to work for such companies. Many Western-based multinational companies have a significant presence in the SSA region. In addition, the European Union (Heyn, 2001), the US Department of State (Fisher-Thompson, 2002), and the U.S. Congress (Lobe, 2003) have concluded that Africa is a current and potentially great trading partner for European and U.S. goods and services. It is therefore of paramount importance to incorporate this region in courses covering global ICT issues.

Conclusion

Sub-Saharan Africa has gone through many decades of exploitation, especially by the West, of its rich natural and human resources (Amin, 1976; Amin, 1990; Griffiths, 1995; Larrain, 1989; Rodney, 1981). This factor--in addition to the many internal problems of bad leadership, corruption, and ethnic divisiveness--has placed the continent of Africa, in general, and SSA in particular, well behind the rest of the world in terms of its socioeconomic development. In the past, the continent of Africa has been depicted as a symbol of negativity, a continent with little hope for progress. The world in general and the news media in particular have found it intriguing and captivating to talk about Africa's problems. However, very little has been done to solve these problems. Unfortunately, the same phenomenon applies to many academic research areas even beyond IS research. Much of the previous research in the area of telecommunications for socioeconomic development has dwelt on SSA's problems, rather than proposed solutions (Odedra et al., 1993; Petrazzini and Kibati, 1999). Furthermore, prevailing research on developing countries as a whole has focused on regions other than Africa. In fact, even those studies that have focused on Africa cover mostly North and South Africa. These two regions do not represent Africa, as they are significantly more developed than countries within the SSA region due to their connections to the Middle East and the West.

Research on telecommunications and related infrastructure solutions to major problems faced by Africans is both interesting and relevant to ICT policy research. International development agencies such as the World Bank, the UN, and USAID can benefit from such research as they look to help this disadvantaged part of the world. In fact, we contend that these agencies could be of great help to SSA, not by giving them financial aid as has been the norm for many decades, but by contributing in building infrastructures for telemedicine, online education, and other ICT-related applications. As UN Secretary General, Kofi Annan, remarked (2003):

> Information and communication technologies can help us turn this potential into concrete opportunities that will help the poor work their way out of poverty. It is not, of course, a magic formula that is going to solve all the problems, but it is a powerful tool for economic growth and poverty eradication, which can facilitate the integration of African countries into the global market.

Research on ICT could provide the basis for prescriptive directions that could benefit policymakers in SSA, improve ICT infrastructure within the region, and create tremendous opportunities for sustainable socioeconomic development,

References

Adam, L. (1996) "Electronic Communications Technology and Development on Internet in Africa," *Information Technology for Development* (7) 3, pp. 133.

Amin, S. (1976) *Unequal Development: An Essay on the Social Formations of Peripheral Economies*. New York: Monthly Review Press.

Amin, S. (1990) *Maldevelopment: Anatomy of Global Failure*. London/New Jersey: Zed.

Annan, K. (2003) "Message from United Nations Secretary General Kofi Annan," World Summit on the Information Society, http://www.itu.int/wsis/annan.html (September, 2004).

Austin, J. E. (1990) *Managing in Developing Countries: Strategic Analysis and Operating Techniques*. New York: Free Press.

Barney, J. B. (1997) *Gaining and Sustaining Competitive Advantage*. Reading, Massachusetts: Addison-Wesley.

BBC (2003) “Ghana Trumps Mighty Microsoft,” in *BBC News Online*. London.

Becker, T. (2001) "Rating the Impact of New Technologies on Democracy," *Communications of the ACM* (44) 1, pp. 39-43.

Bharadwaj, A. S. (2000) "Resource-Based Perspective on Information Technology Capability and Firm Performance: An Empirical Investigation," *MIS Quarterly* (24) 1, pp. 169-196.

Braa, J., E. Macome, J. C. Mavimbe, J. L. Nhanpossa et al. (2001) " A Study of the Actual and Potential Usage of Information and Communication Technology at District and Provincial Levels in Mozambique with a Focus on the Health Sector," *Electronic Journal of Information Systems in Developing Countries* (5) 2, pp. 1-29.

Brown, I. T. J. (2002) "Individual and Technological Factors Affecting Perceived Ease of Use of Web-Based Learning Technologies in a Developing Country," *Electronic Journal on Information Systems in Developing Countries* (9) 5, pp. 1-15.

Brown, I. T. J. and P. S. Licker (2003) "Exploring Differences in Internet Adoption and Usage between Historically Advantaged and Disadvantaged Groups in South Africa," *Journal of Global Information Technology Management* (6) 4.

Brynjolfsson, E. and M. D. Smith (2000) “The Great Equalizer? Consumer Choice Behavior at Internet Shopbots,”. Cambridge, MA.

Careless, J. (2005) “Africa: Broadband and Wireless Services Hold Most Promise,” in *Via Satellite*, vol. 2005.

Chandani, Y. and G. Breton (2001) "Contraceptive Security, Information Flow and Local Adaptations: Family Planning in the Philippines and Morocco," *Electronic Journal of Information Systems in Developing Countries* (5) 3, pp. 1-18.

Chifwepa, V. (1996) "Connectivity in Africa: Use, Benefits and Constraints of Electronic Communication--Zambia," http://www.uneca.org/aisi/nici/country_profiles/zambia/zambpap1.htm (September, 2004).

Cloete, E., S. Courtney, and J. Fintz (2002) "Small Businesses’ Acceptance and Adoption of E-Commerce in the Western-Cape Province of South-Africa," *Electronic Journal on Information Systems in Developing Countries* (10) 4, pp. 1-13.

CNN (2000) "U.S., G-8 Leaders Pledge to Help Developing Countries Join Internet," Cable News Network, http://www.cnn.com/2000/ASIANOW/east/07/22/g8.summit/index.html (September, 2004).

Cobbinah, J. (2003) *Enhancing Strategic Competitiveness in Information and Communication Technology (ICT).* Country Paper, United Nations Conference on Trade and Development.

Cogburn, D. L. (2003) "Governing Global Information and Communications Policy: Emergent Regime Formation and the Impact on Africa," *Telecommunications Policy* (27) 1-2, pp. 135-153.

Crawley, M. (2000) “How AIDS Undercuts Education in Africa,” in *Christian Science Monitor*. Boston.
Darkwa, O. and F. Mazibuko (2000) “Creating Virtual Learning Communities in Africa: Challenges and Prospects,” in *First Monday*, vol. 5.
Darley, W. K. (2001) "The Internet and Emerging E-Commerce: Challenges and Implications for Management in Sub-Saharan Africa," *Journal of Global Information Technology Management* (4) 4, pp. 4-18.
de Vreede, G.-J., N. Jones, and R. J. Mgaya (1999) "Exploring the Application and Acceptance of Group Support Systems in Africa," *Journal of Management Information Systems* (15) 3, pp. 197.
Dlamini, H. (2001) *The Telemedicine Experience*. United Nations Educational, Scientific, and Cultural Organization.
Dutta, A. (1997) "The Physical Infrastructure for Electronic Commerce in Developing Nations: Historical Trends and the Impact of Privatization," *International Journal of Electronic Commerce* (2) 1, pp. 61-83.
Dutta, A. (2001) "Telecommunications and Economic Activity: An Analysis of Granger Causality," *Journal of Management Information Systems* (17) 4, pp. 71-95.
Ein-Dor, P. (2002) "A Global Community of Scholars and the Digital Divide," Association for Information Systems, http://aisnet.org/news/ein-dor060602.shtml (September, 2004).
Erwin, G. J. and C. N. Blewett (1999) "The Influence of Societal Context on Textbook Design in South Africa," *Journal of Global Information Technology Management* (2) 3.
Fisher-Thompson, J. (2002) "U.S. Business Coalition Will Push for Southern African Trade Agreement, U.S. Department of State's Office of International Information Programs," United States Department of State, http://usinfo.state.gov/regional/af/trade/a2111202.htm (September, 2004).
Fleming, S. (2002) "Information and Communication Technologies (ICTs) and Democracy Development in the South: Potential and Current Reality," *Electronic Journal on Information Systems in Developing Countries* (10) 3, pp. 1-10.
Fraser, H. S. F. and S. J. D. McGrath (2000) "Economical Solutions Are Available to Support Health Care in Remote Areas," *British Medical Journal* (321) pp. 465-466.
Gilbert, J. (1996) “A Framework for Building National Information Infrastructure: The Evolution of Increased Reach and Range in Singapore,” in P. C. Palvia, S. C. J. Palvia, and E. Roche (Eds.) *Global Information Technology and Systems Management: Key Issues and Trends*, Westford, Massachusetts: Ivy League Publishing, pp. 55-76.
Goodman, S. E. (1994) "Computing in South Africa: An End to "Apartness"?," *Communications of the ACM* (37) 2, pp. 21.
Grant, R. M. (1991) "The Resource Based Theory of Competitive Advantage: Implications for Strategy Formulation," *California Management Review* (33) 3.
Griffiths, I. L. (1995) *The African Inheritance*. London/New York: Routhledge.
Hamilton, P. (2001) *Leapfrogging the Digital Divide*. Market analysis, World Markets Research Centre.
Hasan, H. and G. Ditsa (1999) "The Impact of Culture on the Adoption of IT: An Interpretive Study," *Journal of Global Information Management* (7) 1, pp. 5-15.
Heyn, A. (2001) "Position Paper for the Bureau of the Africa Caribbean Pacific - European Union Joint Assembly.," http://www.unibw-hamburg.de/NMUNWEB/NMUN2001/Content/Inhalt/position%20papers/seite12.htm (September, 2004).
Hill, C., K. D. Loch, D. W. Straub, and K. El-Sheshai (1998) "A Qualitative Assessment of Arab Culture and Information Technology Transfer," *Journal of Global Information Management* (6) 3, pp. 29-38.

Hoffman, D. L. and T. P. Novak (1998) "Bridging the Racial Divide on the Internet," *Science* (280) pp. 390-391.
Hunt, D. (1997) “The Potential of Telecommunications: Income Distribution in Mercosur,” in *Vital Speeches of the Day*, vol. November 15.
Idowu, P. A., A. O. Alu, and E. R. Adagunodo (2002) "The Effect of Information Technology on the Growth of the Banking Industry in Nigeria," *Electronic Journa l on Information Systems in Developing Countries* (10) 2, pp. 1-8.
IDRC. (1998) “National Information and Informatics Policies in Africa.” *IDRC Regional Seminar, Addis Ababa, Ethiopia, 1998*.
IDRC (2002a) "The Acacia Project," International Development Research Centre, http://web.idrc.ca/en/ev-8455-201-1-DO_TOPIC.html (April, 2004).
IDRC (2002b) "Support for Research," International Development Research Centre, http://www.idrc.ca/admin/Support_Res_e.htm (November, 2002).
ITU (1998) "Mozambique Unveils Leading Edge Telemedicine Facility," International Telecommunication Union, http://www.itu.int/newsarchive/press_releases/1998/01.html (September, 2004).
ITU. (2000) *Telemedicine and Developing Countries*. International Telecommunication Union Document 2/116.
ITU. (2001) *African Telecommunication Indicators*. International Telecommunication Union.
ITU (2004) "World Telecommunication Indicators Database," International Telecommunication Union, http://www.itu.int/ITU-D/ict/publications/world/world.html (September, 2004).
Jensen, M. (1999) *Continental Connectivity Indicators*. Association for Progressive Communications.
Kamel, S. (1995) "IT Diffusion and Socio-Economic Change in Egypt," *Journal of Global Information Management* (3) 2, pp. 4-16.
Karlsbjerg, J., J. Damsgaard, and R. Scheepers (2003) "A Taxonomy of Intranet Implementation Strategies: To Make or to Buy?," *Journal of Global Information Management* (11) 3, pp. 39-62.
Keen, P. G. W. (1991) *Shaping the Future: Business Design through Information Technology*. Cambridge, Massachusetts: Harvard Business School Press.
Khalil, O. E. M. and M. M. Elkordy (1997) "The Relationship of Some Personal and Situational Factors to IS Effectiveness: Empirical Evidence from Egypt," *Journal of Global Information Management* (5) 2, pp. 22-34.
Kibati, M. and D. Krairit (1999) "The Wireless Local Loop in Developing Regions," *Communications of the ACM* (42) 6, pp. 60-66.
Kimbrough, S. O. and R. M. Lee (1997) "Formal Aspects of Electronic Commerce: Research Issues and Challenges," *International Journal of Electronic Commerce* (1) 4, pp. 11-30.
Kowalczykowski, M. (2002) "Disconnected Continent," *Harvard International Review* (24) 2, pp. 40-44.
Larrain, J. (1989) *Theories of Development: Capitalism, Colonialism and Dependency*. Cambridge, Massachusetts: Blackwell.
Lewis, S. G. (1999) "Education in Africa," Microsoft Encarta Africana, http://www.africana.com/research/encarta/tt_215.asp (September, 2004).
Licker, P. S. (2001) "A Gift from the Gods? Components of Information Technological Fatalism, Determinism in Several Cultures," *Electronic Journal on Information Systems in Developing Countries* (7) 1, pp. 1-11.
Light, D. A. (1999) "Pioneering Distance Education in Africa," *Harvard Business Review* (September-October 1999).
Lobe, J. (2003) "New Law to Boost Us-Africa Trade," Africa Recovery Online: A United Nations Publication, http://www.un.org/ecosocdev/geninfo/afrec/vol14no2/trade.htm (September, 2004).

Lowry, P. B., D. Romans, and A. Curtis (2004) "Global Journal Prestige and Supporting Disciplines: A Scientometric Study of Information Systems Journals," *Journal of the Association for Information Systems* (5) 2, pp. 29-77.
Lucas, H. C. (1978) "Empirical Evidence for a Descriptive Model of Implementation," *MIS Quarterly* (2) 2, pp. 27-41.
Mata, F., W. Fuerst, and J. B. Barney (1995) "Information Technology and Sustained Competitive Advantage: A Resource-Based Analysis," *MIS Quarterly* (19) 4, pp. 487-505.
Mbarika, V. A. W. and C. Okoli. (2003) “Telemedicine: A Possible Panacea for Sub-Saharan Africa's Medical Nightmare.” *36th Hawaii International Conference on System Sciences, Waikoloa Village, Hawaii, 2003*.
Mbarika, V. W. A. (2000) “Telecommunications Stakeholders' Perceptions of Strategies to Overcome Teledensity Growth Obstacles of Africa's Least Developed Countries.” *International Conference on Information Systems, Brisbane, Australia, 2000*.
Mbarika, V. W. A. (2001) *Africa's Least Developed Countries' Teledensity Problems and Strategies*. Yaoundé, Cameroon: ME & AGWECAMS Publishers.
Mbarika, V. W. A. (2002) "Rethinking Information and Communications Technology Policy Focus on Internet Versus Teledensity Diffusion for Africa's Least Developed Countries," *Electronic Journal on Information Systems in Developing Countries* (9) 1, pp. 1-13.
Mbarika, V. W. A. (2003) "Telemedicine in Africa: A Possible Panacea for Sub-Saharan Africa's Medical Nightmare," *Communications of the ACM* (Forthcoming).
Mbarika, V. W. A. (2004) "Is Telemedicine the Panacea for Sub-Saharan Africa's Medical Nightmare?," *Communications of the ACM* (47) 7, pp. 21-24.
Mbarika, V. W. A., T. A. Byrd, P. McMullen, and P. Musa (2002a) "Teledensity Growth Constraints and Strategies for Africa's LDCs: "Viagra" Prescriptions or Sustainable Development Strategy?," *Journal of Global Information Technology Management* (5) 1, pp. 25-42.
Mbarika, V. W. A., T. A. Byrd, and J. Raymond (2002b) "Growth of Teledensity in Least Developed Countries: Need for a Mitigated Euphoria," *Journal of Global Information Management* (10) 2, pp. 14-27.
Mbarika, V. W. A., T. A. Byrd, J. Raymond, and P. McMullen (2001) "Investments in Telecommunications Infrastructure Are Not the Panacea for Least Developed Countries Leapfrogging Growth of Teledensity," *International Journal on Media Management* (2) 1, pp. 133-42.
Mbarika, V. W. A., M. M. O. Kah, P. F. Musa, P. Meso et al. (2003) "Predictors of Growth of Teledensity in Developing Countries: A Focus on Middle and Low-Income Countries," *Electronic Journal on Information Systems in Developing Countries* (12) 1, pp. 1-16.
Mbile, P., A. DeGrande, and D. Okon (2003) "Integrating Participatory Resource Mapping and Geographic Information Systems in Forest Conservation and Natural Resources Management in Cameroon: A Methodological Guide," *Electronic Journal on Information Systems in Developing Countries* (14) 2, pp. 1-11.
Meso, P. N. and N. Duncan (2000) "Can National Information Infrastructures Enhance Social Development in the Least Developed Countries? An Empirical Investigation," *Journal of Global Information Management* (8) 4, pp. 30-42.
Miller, J. and B. A. Doyle (1987) "Measuring the Effectiveness of Computer-Based Information System in the Financial Services Sector," *MIS Quarterly* (11) 1, pp. 107-124.
Money, A., D. Tromp, and T. Wegner (1988) "The Implication of Decision Support Benefits within the Context of Value Analysis," *MIS Quarterly* (12) 2, pp. 223-36.
Montealegre, R. (1996) "Implications of Electronic Commerce for Managers in Less-Developed Countries," *Information Technology for Development* (7) 3, pp. 145-52.

Montealegre, R. (1998) "Managing Information Technology in Modernizing "against the Odds": Lessons from an Organization in a Less-Developed Country," *Information & Management* (34) pp. 103-116.

Montealegre, R. (2001) "Four Visions of E-Commerce in Latin America in the Year 2010," *Thunderbird International Business Review* (43) 6, pp. 717-35.

Mubarak, H. (2000) "Mubarak Addresses Message to American People Via Internet (3/29/2000)," ArabicNews.com, http://www.arabicnews.com/ansub/Daily/Day/000329/2000032918.html (September, 2004).

Mursu, A., A. H. Soriyan, K. C. Olufokunbi, and M. Korpela (1999) "From Software Risks to Sustainable Information Systems: Setting the Stage for a Delphi Study in Nigeria," *Journal of Global Information Technology Management* (2) 3.

Nidumolu, S. R., S. E. Goodman, D. R. Vogel, and A. K. Danowitz (1996) "Information Technology for Local Administration Support: The Governorates Project in Egypt," *MIS Quarterly* (20) 2, pp. 197-224.

Odedra, M., M. Lawrie, M. Bennet, and S. E. Goodman (1993) "Sub-Saharan Africa: A Technological Desert," *Communications of the ACM* (36) 2, pp. 25-29.

Odedra-Straub, M. (1993) "Critical Factors Affecting Success of CBIS: Cases from Africa," *Journal of Global Information Management* (1) 3, pp. 16.

OHRLLS. (2003) *List of LDCs, LLDCs and SIDS*. United Nations Office of the High Representative for the Least Developed Countries (LDCs), Landlocked Developing Countries (LLDCs) and Small Island Developing States (SIDS).

Okoli, C. (2003) Expert Assessments of E-Commerce in Sub-Saharan Africa: A Theoretical Model of Infrastructure and Culture for Doing Business Using the Internet. Dissertation, Louisiana State University.

Okoli, C. and V. W. A. Mbarika (2003) "A Framework for Assessing E-Commerce in Sub-Saharan Africa," *Journal of Global Information Technology Management* (6) 3.

Okunoye, A. and H. Karsten (2002) "Where the Global Needs the Local: Variation in Enablers in the Knowledge Management Process," *Journal of Global Information Technology Management* (5) 3.

Pegasus Research (2003) "Latin American Web Users," Pegasus Research International, http://www.pegasusresearch.net/metrics/growthla.htm (September, 2004).

Peha, J. M. (1999) "Lessons from Haiti's Internet Development," *Communications of the ACM* (42) 6, pp. 67-72.

Petrazzini, B. and M. Kibati (1999) "The Internet in Developing Countries," *Communications of the ACM* (42) 6, pp. 31-6.

Press, L. (1999) "Second Internet Diffusion Survey," *OnTheInternet* (5) 6.

Rahedi, B. (2002) "Wireless in LDC'S: A Solution to the Telecommunications Industry?," Kent State University, http://asgard.kent.edu/collabwork/Spring2002/wireless.in.LDCs.ppt (September, 2004).

Raman, K. S. and C. S. Yap (1996) "From a Resource Rich Country to an Information Rich Society: An Evaluation on Information Technology Policies in Malaysia," *Information Technology for Development* (7) 3, pp. 109-31.

Rischard, J. (1996) " Foreward to Harnessing Information for Development: A Proposal for a World Bank Group Strategy," http://www.worldbank.org/html/fpd/telecoms/harnessing/foreword.html (September, 2004).

Rodney, W. (1981) *How Europe Underdeveloped Africa*. Washington, DC: Howard University Press.

Rose, G. and D. W. Straub (1998) "Predicting General IT Use: Applying TAM to the Arabic World," *Journal of Global Information Management* (6) 3, pp. 39-46.

Rosenberg, D. (1998) "IT and University Libraries in Africa," *Internet Research* (8) 1, pp. 5-13.
Rosenberg, D. (1999) "CD-ROM: A Sustainable and Sustaining Medium for African Libraries?," *Online & CD - ROM Review* (23) 4, pp. 231.
SAIDE. (1999) *Report of the South African Institute for Distance Education: Country Visits*. World Bank.
Salem, S. (1986) "Information Infrastructure in the Arab Countries: An Analysis," *Journal of Information Science* (12) 5, pp. 217.
SATELLIFE (2001) "SATELLIFE: The Global Health Information Network," SATELLIFE, http://www.healthnet.org (September, 2004).
Shirley, M. M. (1999) "Experience with Privatisation: A New Institutional Economics Perspective," *Journal of African Economies* (11) 1, pp. 10-31.
Solomon, A., M. Kifle, V. A. W. Mbarika, and C. Okoli. (2004) “Telemedicine Endeavors in Ethiopia: Potential Benefits, Present Challenges, and Potential Factors.” *5th Annual Global Information Technology Management (GITM) World Conference, San Diego, 2004*.
Soriyan, H. A., A. S. Mursu, A. D. Akinde, and M. J. Korpela (2001) "Information Systems Development in Nigerian Software Companies: Research Methodology and Assessment from the Healthcare Sector's Perspective," *Electronic Journal of Information Systems in Developing Countries* (5) 4, pp. 1-18.
Splettstoesser, D. and F. Kimaro (2000) "Benefits of IT-Based Decision-Making in Developing Countries," *Electronic Journal of Information Systems in Developing Countries* (3) 3, pp. 1-12.
Splettstoesser, D. and A. Towry-Coker (1999) "Model of an Information and Decision Centre for Developing Countries," *Journal of Global Information Technology Management* (2) 1, pp. 10-30.
Straub, D. W. (2003) “Social and International Issues,” in *Foundations of Net-Enhanced Organizations*, New York: Wiley, pp. 465-502.
Straub, D. W., K. D. Loch, R. Evaristo, E. Karahanna et al. (2002) "Toward a Theory Based Definition of Culture," *Journal of Global Information Management* (10) 1, pp. 13-23.
Straub, D. W., K. D. Loch, and C. E. Hill (2001) "Transfer of Information Technology to Developing Countries: A Test of Cultural Influence Modeling in the Arab World," *Journal of Global Information Management* (9) 4, pp. 6-28.
Thapisa, A. P. N. (1996) "The Impact of Global Information on Africa," *Internet Research* (6) 1, pp. 71-78.
Travica, B. (2002) "Diffusion of Electronic Commerce in Developing Countries: The Case of Costa Rica," *Journal of Global Information Technology Management* (5) 1, pp. 4-24.
UNECA. (1999a) *The African Connection Rally Country Fact Sheets*. United Nations Economic Commission for Africa.
UNECA. (1999b) *The Eca and Africa: Accelerating a Continent's Development*. United Nations Economic Commission for Africa.
UNECA (1999c) "Electronic Commerce in Africa," United Nations Economic Commission for Africa, http://www.uneca.org/adf99/adf99ecommerce.htm (September, 2004).
USA Today (1999) “African Colleges Get Global Help Via the Net,” in *USA Today Tech Report*.
USAID (2003) "Congressional Budget Justification for Sub-Saharan Africa," USAID, http://www.usaid.gov/policy/budget/cbj2004/sub-saharan_africa/ (September, 2004).
Vadapalli, A. and K. Ramamurthy (1998) "Business Use of the Internet: An Analytical Framework and Exploratory Case Study," *International Journal of Electronic Commerce* (2) 2, pp. 71-94.
Vessey, I., V. Ramesh, and R. L. Glass (2002) "Research in Information Systems: An Empirical Study of Diversity in the Discipline and Its Journals," *Journal of Management Information Systems* (19) 2, pp. 129-174.

Wellenius, B. (1984) "Telecommunications in Developing Countries," *Finance and Development* pp. 33-46.
WHO (2001) "Global Summary of the HIV/AIDS Epidemic," United Nations, http://www.UNAIDS.org (September, 2004).
Wilson, B. and P. Darmuzey (2000) "Distance Learning, the African Virtual University, and Eu-World Bank Co-Operation," *Social, Human & Cultural Development* 24.
Wolcott, P., L. Press, W. McHenry, S. E. Goodman et al. (2001) "A Framework for Assessing the Global Diffusion of the Internet," *Journal of the Association for Information Systems* (2) 6, pp. 1-50.
World Bank. (2001) *World Development Indicators*. World Bank.
Wresch, W. (2003) "Initial E-Commerce Efforts in Nine Least Developed Countries: A Review of National Infrastructure, Business Approaches, and Product Selection," *Journal of Global Information Management* (11) 2.
Yavwa, Y. and P. S. Kritzinger (2001) "Enabling Communication in Developing Regions," *Electronic Journal on Information Systems in Developing Countries* (6) 1, pp. 1-15.
Zmud, R. W. (1995) "Editor's Comments," *MIS Quarterly* (19) 2.
Zwass, V. (1996) "Electronic Commerce: Structure and Issues," *International Journal of Electronic Commerce* (1) 1, pp. 3-23.

About the Authors

Victor W. Mbarika is on faculty in the College of Business at Southern University. He holds a B.S. in Management Information Systems from the U.S. International University, M.S. in MIS from the University of Illinois at Chicago, and Ph.D. in MIS from Auburn University. His research on information and communications technology diffusion in developing countries and on multimedia learning has been published (or are forthcoming) in 22 academic journals, four book chapters, and over 45 national and international conferences publications proceedings. Dr. Mbarika is Founder of the Cameroon Computer and Network Center (CCNC). He is a member of the AIS, IEEE, and IRMA.

Chitu Okoli is an assistant professor in management information systems at the John Molson School of Business of Concordia University, Montréal. He obtained a PhD in information systems and decision sciences from Louisiana State University in 2003. He researches applications of the Internet in developing countries, open source software and encyclopedias, and strategically using the Internet for competitive advantage. He teaches business data communications and website development.

Terry Anthony Byrd is Professor of MIS in the Department of Management at the College of Business, Auburn University. He holds a BSEE from the University of Massachusetts at Amherst and a Ph.D in MIS from the University of South Carolina. His research has appeared in MIS Quarterly, JMIS, Decision Sciences, OMEGA, Interfaces and other leading journals. His current research interests include healthcare informatics and electronic commerce.

Pratim Datta is an Assistant Professor of Information Systems at Washington State University. He received his PHD and MS in Information Systems and Decision Sciences from Louisiana State University. His current research interests include IT Infrastructure development and IT enabled performance in global organizations and economies.

APPENDIX A. MAP OF SUB-SAHARAN AFRICA

APPENDIX B: SELECTED TELECOMMUNICATION INDICATORS FOR SUB-SAHARAN AFRICA

Key to Table

Country	Name of the country
Popn	Population in thousands
GDP	Per capita GDP in US$
Land	Landline teledensity—number of land lines per 100 citizens
Cell	Mobile teledensity—number of mobile phone subscriptions per 100 citizens
TD	Total teledensity—Landline teledensity plus mobile teledensity
Hosts	Total number of Internet servers (hosts)
Internet	Number of Internet users per 1,000 citizens
PC	Number of personal computers per 1,000 citizens
All data is for 2003, or most recent available from 2000 to 2002 (ITU, 2004)	

Country	Popn	GDP	Land	Cell	TD	Land	Cell	TD	Hosts	Internet	PC
			2001			1991					
Angola	13,937	$715	0.61	0.93	1.54	0.75	0.00	0.75	7	2.9	1.9
Benin	6,801	$413	0.92	3.22	4.14	0.31	0.00	0.31	574	7.4	2.2
Botswana	1,720	$2,939	8.72	24.13	32.85	2.46	0.00	2.46	1,617	29.7	40.7
Burkina Faso	11,959	$220	0.54	0.75	1.29	0.20	0.00	0.20	409	2.1	1.6
Burundi	6,988	$89	0.32	0.74	1.06	0.18	0.00	0.18	3	1.2	0.7
Cameroon	15,830	$623	0.70	4.27	4.97	0.35	0.00	0.35	439	3.8	5.7
Cape Verde	439	$1,239	15.99	9.78	25.77	2.59	0.00	2.59	48	36.4	79.7
Central African Rep.	3,957	$265	0.23	0.32	0.55	0.18	0.00	0.18	6	1.3	2.0
Chad	7,872	$212	0.15	0.43	0.58	0.07	0.00	0.07	11	1.9	1.7
Comoros	762	$303	1.35	N/A	1.35	0.81	0.00	0.81	12	4.2	5.5
Congo	3,300	$967	0.67	6.72	7.39	0.74	0.00	0.74	36	1.5	3.9
Congo (Dem. Rep.)	52,647	$143	0.02	1.06	1.08	0.09	0.00	0.09	134	0.9	N/A
Cote d'Ivoire	16,490	$711	2.04	6.23	8.27	0.67	0.00	0.67	4,397	5.5	9.3
Djibouti	656	$894	1.54	2.29	3.83	1.18	0.00	1.18	498	6.9	15.2
Equatorial Guinea	505	$4,289	1.74	6.34	8.08	0.36	0.00	0.36	3	3.6	6.9
Eritrea	3,980	$146	0.90	N/A	0.90	N/A	N/A	N/A	859	2.3	2.5
Ethiopia	67,347	$96	0.53	0.07	0.60	0.27	0.00	0.27	41	0.7	1.5
Gabon	1,299	$3,611	2.47	21.50	23.97	2.70	0.00	2.70	79	19.2	19.2
Gambia	1,372	$333	2.80	7.29	10.08	1.05	0.00	1.05	568	18.2	13.8
Ghana	21,674	$209	1.27	2.07	3.34	0.30	0.00	0.30	313	7.8	3.8
Guinea	7,665	$381	0.34	1.18	1.52	0.19	0.00	0.19	251	4.6	5.5
Guinea-Bissau	1,253	$173	0.89	N/A	0.89	0.63	0.00	0.63	20	4.0	N/A
Kenya	31,930	$386	1.03	4.15	5.18	0.88	0.00	0.88	2,963	12.5	6.4
Lesotho	2,167	$330	1.32	4.25	5.57	0.69	0.00	0.69	45	9.7	N/A
Liberia	3,238	N/A	0.22	0.06	0.28	0.12	0.00	0.12	11	0.3	N/A
Madagascar	15,911	$277	0.37	1.02	1.40	0.31	0.00	0.31	509	3.5	4.4
Malawi	10,437	$158	0.70	0.82	1.52	0.33	0.00	0.33	17	2.6	1.3
Mali	10,629	$318	0.53	0.50	1.03	0.15	0.00	0.15	158	2.4	1.4
Mauritania	2,682	$365	1.18	9.22	10.39	0.32	0.00	0.32	79	3.7	10.8
Mauritius	1,210	$3,957	27.03	28.91	55.95	5.99	0.23	6.22	3,462	99.1	116.5
Mayotte	148	N/A	6.98	14.66	14.66	3.44	0.00	3.44	N/A	N/A	N/A
Mozambique	18,234	$215	0.46	1.40	1.86	0.37	0.00	0.37	1,925	1.7	4.5
Namibia	1,875	$1,697	6.48	8.00	14.48	4.04	0.00	4.04	3,709	26.7	70.9
Niger	11,747	$165	0.19	0.14	0.33	0.12	0.00	0.12	119	1.3	0.6
Nigeria	120,079	$409	0.58	1.34	1.92	0.30	0.00	0.30	1,030	3.5	7.1
Reunion	744	N/A	41.04	65.88	65.88	28.63	0.00	28.63	1	205.2	71.3
Rwanda	8,171	$208	0.28	1.36	1.64	0.19	0.00	0.19	1,233	3.1	N/A
Sao Tome & Principe	151	$331	4.13	1.31	5.44	1.90	0.00	1.90	1,069	72.8	N/A
Senegal	10,077	$506	2.23	5.49	7.72	0.65	0.00	0.65	761	10.4	19.8
Seychelles	81	$7,571	26.91	55.35	82.25	13.27	0.00	13.27	266	145.2	160.8
Sierra Leone	4,952	$152	0.48	1.34	1.82	0.33	0.00	0.33	277	1.6	N/A
Somalia	10,162	N/A	0.98	0.34	1.33	0.17	0.00	0.17	4	8.8	N/A
Sudan	32,539	$396	2.06	0.59	2.65	0.25	0.00	0.25	600	2.6	6.1
Swaziland	1,032	$1,130	3.40	6.10	9.50	1.75	0.00	1.75	1,329	19.4	24.2
Tanzania	34,444	$271	0.47	1.95	2.41	0.31	0.00	0.31	1,731	2.3	4.2
Togo	4,873	$301	1.05	3.49	4.54	0.29	0.00	0.29	80	41.0	30.8
Uganda	24,700	$243	0.22	1.59	1.81	0.17	0.00	0.17	2,242	4.0	3.3
Zambia	10,696	$312	0.82	1.30	2.12	0.86	0.00	0.86	1,621	4.9	7.5
Zimbabwe	11,635	$654	2.47	3.03	5.51	1.25	0.00	1.25	2,382	43.0	51.6
SSA	**632,994**	**$346**	**0.89**	**1.94**	**2.81**	**0.43**	**0.00**	**0.43**	**37,948**	**5.3**	**7.0**
South Africa	**45,454**	**$2,293**	**10.66**	**30.39**	**41.05**	**9.49**	**0.02**	**9.51**	**198,853**	**68.2**	**72.6**
Algeria	31,293	$1,773	6.10	1.28	7.38	3.44	0.02	3.46	821	16.0	7.7
Egypt	67,313	$1,279	11.04	6.68	17.72	3.35	0.01	3.36	3,061	28.2	16.6
Libya	5,555	$6,207	11.83	1.26	1.26	4.95	0.00	4.95	83	22.5	23.4
Morocco	29,643	$1,162	3.80	20.91	24.71	1.99	0.01	1.99	2,680	23.6	23.6
Tunisia	9,781	$2,152	11.74	5.15	16.89	3.99	0.01	4.01	341	51.7	30.7
North Africa	**143,585**	**$1,605**	**8.55**	**8.13**	**16.67**	**3.19**	**0.01**	**3.20**	**6,986**	**26.0**	**17.4**
Africa	**822,033**	**$668**	**2.77**	**4.58**	**7.35**	**1.46**	**0.00**	**1.46**	**243,787**	**12.4**	**13.0**
World	**6,188,825**	**$5,346**	**17.70**	**18.93**	**36.54**	**10.23**	**0.30**	**10.53**	**157,616,680**	**101.3**	**98.7**

Journal of the Association for Information Systems
ISSN: 1536-9323